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To..

From the E. M. Museum of Geology
and Archæology of the College of
New Jersey.
A. GUYOT, Director.
Princeton, N. J.

OF

The Princeton Scientific Expedition

OF 1877.

BY
HENRY F. OSBORN,
WM. B. SCOTT,
FRANCIS SPEIR, JR.

SEPTEMBER 1, 1878.

NEW YORK:
S. W. GREEN, PRINTER, NOS. 16 AND 18 JACOB STREET.
1878.

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CONTRIBUTIONS FROM THE MUSEUM OF GEOLOGY AND ARCHÆOLOGY OF PRINCETON COLLEGE.

No. 1.

PALÆONTOLOGICAL REPORT

OF

The Princeton Scientific Expedition

OF 1877.

BY

HENRY F. OSBORN,
WM. B. SCOTT,
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PALÆONTOLOGICAL DIVISION.

PROF. JOSEPH KARGÈ,
ROLLIN H. LYNDE,
HENRY F. OSBORN,
JOTHAM POTTER,
WM. B. SCOTT,
FRANCIS SPEIR, JR.

To the Honorable the President and Board of Trustees of the College of New Jersey:

Gentlemen:

I have the honor to transmit herewith the Palæontological Report of the College Scientific Expedition of 1877.

The fossils collected by the Palæontological party, and deposited by the chief of the expedition in the Geological Museum, consisted of two sets, one numbering some two thousand specimens of fossil plants and insects from the tertiary beds of Central Colorado, the other of a considerable series of fossil vertebrates, mostly mammals, from the tertiary beds of Wyoming Territory, around Fort Bridger. This last collection has been studied and worked out with unabated zeal and diligence by the three post-graduate members of the Palæontological party, Messrs. H. Osborn, W. Scott, and F. Speir, who devoted most of the time of their course to this special work, with what success this Report will show.

It will be a source of gratification to the generous friends of the College, who furnished means for the Scientific Expedition of 1877, *that it not only enriched our Museum to so great an extent, but did more still by fostering in our College a thorough study of Palæontology, which could not have been undertaken without such means as these thus placed at the disposal of our students.*

The fossil insects and plants have been intrusted to the hands of the best specialists for determination. Dr. S. Scudder, of Cambridge, Mass., has kindly consented to revise the insects, Prof. G. L. Lequereux the plants.

Very Respectfully,

A. GUYOT,

Director of the E. M. Museum of Geology and Archæology.

PRINCETON, June 1, 1878.

SIR: We transmit herewith our report upon the Palæontological collections made by the Princeton party in the summer of 1877.

The following persons constituted the Palæontological division: ROLLIN H. LYNDE, HENRY F. OSBORN, JOTHAM POTTER, WM. B. SCOTT, FRANCIS SPEIR, Jr. The division remained in Colorado from the first of July until the first of August, when, under the direction of Professor Kargè, it left the main party, and passed the month of August in Wyoming, returning in the first part of September. The Colorado collections were mostly made in the (probable) Miocene beds near Florissant, and in the beds near the Garden of the Gods, variously referred to the *Dakota* and *Wealden* groups. In Wyoming, with Fort Bridger as a base of explorations, the division was wholly occupied in the Bridger series, camping successively on Smith's Fork, Henry's Fork, and Dry Creek, and exploring the beds adjacent.

It has been our endeavor, in confining our attention to the remains of vertebrated animals collected during the trip, not merely to catalogue the direct results, but, by the aid of fresh materials, to supplement the work of others. For, of the descriptions and data of the Bridger Eocene Fauna published up to the present time, we find that even those which have been most accurately prepared are lacking in important details; and that, owing to imperfect materials, large gaps yet remain in our knowledge of genera and species named and classed years ago. Although such supplementary work may appear, at first sight, tedious and ill-directed, we are confident that in the end it will prove of some value to science, and that it is therefore well worthy of our effort. While our field work did not extend beyond a region previously well explored, we obtained material by means of which we are able to add a number of new ossils to the Eocene Fauna of the Bridger group.

In the preparation of this report we have experienced much difficulty in assigning some of our specimens to their proper genera and species. For, while we have desired to respect the classifications made by others, we have in many cases found it impossible to do so, owing to uncharacteristic definition, which, without doubt, has been unavoidable. In all cases of uncertainty, we have adopted the classification which appeared to be the best established. This, in short, has proved the only available course.

The drawings have been executed with much care as to accuracy of proportion and outline. They are, with one exception, the work of a member of the party; and they are inserted simply to illustrate certain parts of the conte which would be unsatisfactory without reference to figures of the kind.

Now that the present work is ready for the press, we are very sensible th it must contain errors which, while they have escaped our notice, will be readi detected by eyes more experienced. These, we trust, will be excused, whe it is remembered that we are just entering a field which others have explore for years; and opening a work which Princeton, with her many other lin of study, has never hitherto attempted.

We take this opportunity to return our most hearty thanks to Gener Flint, to Judge and Dr. Carter, to Mr. Hamilton, and other officers an residents at Fort Bridger, who, by their good will and liberal assistance, contributed largely to our success. Our gratitude is also due to Professors Leidy and Cope for their generous aid, both in the way of advice and of material put in our hands for comparison.

The following pages do not embrace descriptions of the entire collections made by the Princeton party last summer. The valuable specimens of fossil plants and insects have passed into other hands.

Respectfully submitted,

HENRY F. OSBORN,
WM. B. SCOTT,
FRANCIS SPEIR, Jr.

Dr. Arnold Guyot,
Director of the E. M. Museum.

INTRODUCTORY NOTE

UPON THE

GEOLOGY OF THE BRIDGER BASIN.

FORT BRIDGER is a government military post, situated on the high southern plateau of western Wyoming Territory, in the midst of one of the most interesting geological regions of the world.

The country on all sides was once the bottom of a great eocene lake, the water of which was probably slightly brackish. Whether this lake district had direct communication with the ocean, is undetermined as yet, but there is a possibility that it had.*

The tributaries of the Green River, which drain this plateau, render the valleys along the edges of the streams green and wooded. Beyond this fertile strip, wide, barren plains extend, covered by a dense growth of short "sage brush" (Artemisia tridentata).

From the fragmentary débris lying scattered over the surface of the ground, it would seem as if the various streams formerly were of much greater size and volume than they now are, and that long after the eocene lakes had been drained-rivers of considerable size ploughed up the lake bottoms, excavating an immense area. The formation known as "Mauvaises Terres" rises abruptly from the valleys, and extends in a series of plateaus, one above the other, on either side.

The high land shows the effect of violent erosion in two forms ; first, the irregular and jagged cones that appear upon the sides of the high benches ; and, second, the isolated butte structure, rising directly out of the plain.

The bad lands of Cottonwood Creek, Henry's Fork, Dry Creek, etc., are examples of the first, and Bridger Butte the best known example of the second.

Bridger Butte, six miles to the south-west of Fort Bridger, rises to a height of over a hundred feet, and is about two miles long ; its sides slope steeply up, and its level top serves as a landmark that can be seen miles away.

The stratification throughout this whole formation is nearly horizontal, and across the valley can be distinctly noted, owing to the color and appearance of the various layers.

No satisfactory explanation has been given of the causes which occasioned the removal of the waters of these lakes, nor of the agencies necessary to accomplish the great excavations that now show the former bottoms of the basins. These and like points future investigation will undoubtedly solve.

---

* Ichthyic fauna of the Green River shales, Hayden's Surveys, vol. iii., No. 4, p. 819.

It is certain that the level of the lakes varied at different times, and also that great stretches of marshy land surrounded their borders.

The first fact is proved by the characters oft he different layers of strata ; the second by the fossil remains entombed. A careful study of the formation of the beds of Cottonwood Creek, at a point about fourteen miles south of Fort Bridger, yielded the following result, which will serve as an example illustrative of the regular formation in this section.

Three distinct lines of bluffs are to be noticed, the first rising to a height of one hundred and fifty feet ; from these extends a plain, gently sloping south-west to the foot of the second line of cliffs; these seem high, owing to the downward slope of the plain, but they really rise only fifty feet higher than the first.

On the top of the second, but less broad than the first, extends a level plain, with a slight dip to the south-east ; at the end of this, the third line rises two hundred feet above the top of the second line of bluffs, making a total height, in the series, of four hundred feet above the level of Smith's Fork.

The strata throughout are nearly horizontal, and are of different color and composition.

Specimens of the rocks and clays from this section were gathered, and submitted for analysis to Professor Cornwall, of the Scientific School at Princeton, who has kindly furnished us with the following notes :

No. 1, very friable, light greenish-gray sedimentary rocks, consisting chiefly of crystalline grains of quartz, orthoclase, and hornblende (this often in slender crystals), with a little dark mica, and irregular fragments of a light-greenish, transparent, not dichroitic mineral. The above are not perceptibly affected by hot hydrochloric acid. The whole is loosely cemented with a calcareous clay, containing considerable phosphoric acid. These rocks might result from the disintegration of a neighboring hornblendic granite.

The greatest mass of the strata is made up of this kind of rock, and it is this which gives the peculiar color to the " Mauvaises Terres."

Above this in places is found a second kind, which is a light gray indurated clay, with a slight greenish tint. It contains much fine crystalline quartz, with considerable carbonate of lime, and a little phosphoric acid.

It appears to be of similar origin with the first, but was deposited in quieter waters. This mineralogical evidence is strengthened by the fact that no remains of mammals were found in strata of this kind, but only shells regularly deposited in layers one above another.

The third kind is found in thin layers, overtopping the highest line of buttes ; it consists of very fine-grained dark-brown sandstones, containing a considerable proportion of carbonate and phosphate of lime. They are hard and tough, and are mechanically deposited, and no fossils are found in them.

In No. 2 the indurated clay is often found above a coarser sandstone than No. 1, but of the same general appearance ; with the exception that it contains smooth, rounded pebbles, which were deposited either on a beach or in running water. In this stratum the fossils found are separate bones, often showing marks of having been broken before they were silicified. This would prove that the lake level was changing continually.

Several skeletons of animals have been found in a standing position, with their legs slightly stretched out. They were probably mired, and, being unable to extricate themselves, died in an erect position. This fact affords evidence that extensive swamps surrounded the borders of the lake.

The snow-water and the spring rains wear deep gulleys through the lines of cliffs, and wash down fragments of bones into the dried-up water-courses. These pieces can generally be traced up to the spot from which they came, and the rest of the skeleton can so be secured.

The fossils found in the eocene of Wyoming are entirely petrified, presenting a darker appearance than their matrix; but loose bones washed out, and subjected to the influence of the sun and rain, often become bleached so as to resemble in color modern bones.

The state of preservation of the fossils differs according to the matrix in which they are found. Generally speaking, the remains found in the lower lines of buttes have been considerably distorted by pressure; while those from the highest line have suffered very little from this cause.

MAMMALIA.

PRIMATES.

TOMITHERIUM, Cope.

Ann. Rep. U. S. Geol. Survey of Terrs. 1872, p. 546.

"DENTAL formula of the inferior series: I. 2, C. 2, Pm. 4, M. 3. The last molar has an expanded heel. The third premolar consists of a cone with posterior heel. Fourth premolar exhibits, besides its principal cone, an interior lateral one and a large heel. The true molars support two anterior tubercles, of which the inner is represented by two distinct cusps in one or more of them, and the external is crescentoid in section. The posterior part of the crown is wide and concave, and bordered at its posterior angles by an obsolete tubercle on the inner, and an elevated angle on the outer side." (Palæontology, Wheeler's Survey, IV (pt. 2), p. 135.)

TOMITHERIUM ROSTRATUM, Cope.

Loc. cit., p. 548.

This species exhibits considerable variation, both in size and proportion of the teeth. We have two specimens of it, one of which agrees exactly with the measurements given by Professor Cope, while the other is stouter, and probably belonged to an old male.

The incisors are too much broken for description. The canine has a long, stout fang, which is subcircular in section;

the crown is compressed, and shows a distinct cutting edge posteriorly. It is short, and tapers rapidly; in this respect differing from *Notharctus*, Leidy, which has a long recurved canine. The first and second premolars are inserted each by a single fang; the third and fourth by two. The third premolar consists of a simple conical crown with a small posterior heel; and the fourth has this heel enlarged, with a small tubercle developed inside and slightly behind the principal lobe. All the premolars have striated enamel, and very feebly marked basal ridges.

The true molars are considerably larger than the premolars; the third is the longest of the series, and the second is the widest. They all seem to be inserted by two fangs. The posterior fang of the last molar is a flat quadrate, of the same size throughout, having a great fore-and-aft diameter, and apparently no nerve cavity. The mandible is strong but shallow, has a curved alveolus and lower margin, and the teeth form a curve with convexity outwards. The symphysis is short and oblique.

This genus presents a close resemblance to the modern *Lemur*, but at the same time shows several differences. We may give these differences in systematic order: (1) Greater number of premolars, in *Tomitherium* = 4, in *Lemur* = 2. It will be observed, however, that the first and second premolars of *Tomitherium* are very small and single-rooted, and that their disappearance is a comparatively slight change. (2) The canines are subcircular in section, not nearly so much compressed. (3) Greater breadth of the molars in proportion to their length. (4) Two internal cusps on the molar. (5) Much greater size of the last molar. (6) Greater depth and thickness of the jaw. (7) Greater curvature of alveolus and lower margin of ramus. (8) Longer and more oblique symphysis.

The third and fourth premolars of *Tomitherium* correspond almost exactly to the first and second of *Lemur*, but they are not quite so high and sharp. The interior tubercle of the second premolar is not so distinct in the latter genus.

In the second specimen the cusps are all low, and the crests prominent, giving the molars something of the appearance of *Opisthotomus*. This difference is probably sexual.

Measurements.

	M. T. No. 1.	M. T. No. 2.	M. Lemur.
Length of entire molar series	·038	....	·032
Length of premolar series	·017	....	·0125
Length of true molar series	·021	....	·0195
Fore-and-aft diameter of canine	·003	·005	·0065
*Length of last molar	·008	....	·005
Width of last molar	·004	....	·003
Length of second molar	·007	·007	·0072
Width of second molar	·005	·006	·005
Length of last premolar	·0055	...	·007
Length of penultimate premolar	·004	....	·005
Depth of jaw at second molar	·012	·012	·0095
Thickness of jaw at second molar	·0065	·009	·004

Specimen No. 1 was found at Cottonwood Creek, and specimen No. 2 at Henry's Fork, Wyoming.

HYOPSODUS, Leidy.

Pr. Ac. Nat. Sc., 1870, p. 110.

Lower teeth: I. 3, C. 1, Pm. 4, M. 3, in uninterrupted succession. Last molar has cusps in opposing pairs; the antero-internal cusp on all the molars is single; the last molar has a heel, and the last premolar has an inner cusp. The true molar cusps are all high and simple.

HYOPSODUS PAULUS, Leidy.

Loc. cit., p. 110.

This is one of the most common fossils found in the Bridger Basin. We have numerous specimens, chiefly from Henry's Fork, exhibiting a large range of individual and sexual variation. As Dr. Leidy has already pointed out, the strength and depth of the lower jaw is extremely variable, increasing with the age of the animal; so that the most worn teeth are associated with the deepest jaws.

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* In measurements of teeth we use the word *length* to mean antero-posterior diameter, and *width* to mean transverse diameter.

In addition to the jaws and teeth, (which have been very accurately described), we have a portion of a pelvis and femur, which are important as tending to confirm the reference of this genus to the Lemurs.

The *pelvis* is represented by the acetabulum and a small portion of ilium and ischium. They resemble the corresponding parts in the skeleton of *Stenops gracilis*. The acetabulum is a long oval, not subcircular, deep, and quite narrow from side to side. It appears to be directed nearly straight outwards. The ilium is narrow, has a concave gluteal surface, and a prominent acetabular border. The pubis evidently projected forward, making a right angle with the ilium; while the ischium is slender and nearly in the same plane with the ilium. The *femur* is thoroughly lemurine in shape. The shaft, (as much of it as is preserved), is straight and subcylindrical; it is not flattened even distally, but becomes very thick and trihedral in shape just above the trochlea. The trochlea is long, and rises obliquely upon the shaft; the groove is deep, and the two divisions are asymmetrical, the external somewhat the larger. The condyles are large. They are but slightly convex in either direction and project backwards, and are broadest posteriorly. The internal is the larger. They are separated by a deep but not wide popliteal groove, which does not extend into a popliteal fossa. The position and shape of the condyles are such as show that the femur must have been very oblique to the tibia, as in the other lemurs. The tuberosities, especially the internal, are very large and prominent. The whole distal end has an asymmetrical appearance, owing to the greater size of the internal condyle.

Measurements.

	M.
Breadth of ilium at acetabulum	·0065
Vertical diameter of acetabulum	·007
Transverse diameter of acetabulum	·009
Fore-and-aft diameter of shaft of femur above trochlea	·0065
Transverse diameter of shaft above trochlea	·0065
Width of trochlea	·004
Length of trochlea	·0075
Breadth over condyles	·010
Breadth of inner condyles	·005

OLIGOTOMUS, Cope.

Ann. Rep. U. S. Geol. Survey of the Terrs., 1872, p. 607.

" Molars constructed much as in *Hyopsodus* and *Lophiotherium*, viz., with two external subtrihedral cusps which wear into crescents, the posterior connected by a low oblique ridge with the basis of the anterior cone of the inner side; the latter with two conic cusps. It differs from these genera and from *Orotherium* in the possession of two premolars; the inferior molars are probably six, leaving four true molars."

OLIGOTOMUS CINCTUS, Cope.

Loc. cit.

Represented in our collection by the penultimate lower molar, and a caudal vertebra, which has a remarkably long, slender, and simple centrum, with rudimentary metapophyses

OPISTHOTOMUS, Cope.

Wheeler's Survey, Pal. v. iv., pt. II, p. 152.

" The inferior lower molars do not display a bifid or double anterior cusp; and the crowns exhibit two anterior cones, and an inner cone and outer crescent posteriorly. The posterior crescent is well defined, and is continued on a narrow crest to the anterior inner tubercle. The posterior molar presents the peculiarity of a series of three cusps in one line, the median having another or lateral cusp near it."

This genus has hitherto been found only in the Wahsatch formation; but we have discovered it to be represented in the Bridger series by the species *O. astutus*, Cope. Our specimen consists of a part of the ramus mandibuli containing a single molar tooth.

CARNIVORA.

SINOPA, Leidy.

A genus of small carnivorous animals, which Dr. Leidy regards as intermediate between the recent *Canis* and the extinct *Hyænodon*. Owing to the fragmentary condition of the remains found, no satisfactory generic definition has been given.

From the portion in our collection, we are able to throw some further light upon the genus, summing up the generic characteristics thus: Small carnivores, which have the last upper premolar as sectorial (thus differing from *Hyænodon*), the other premolars simple and conical.

The sectorial is shorter, antero-posteriorly, than the preceding tooth; has a short blade of a single lobe, and a large cusp developed from the posterior part; a cingulum surrounds the entire crown. The *lower* sectorial has the blade of a single lobe, and with a short heel.

SINOPA RAPAX, Leidy.

Proceedings of Ac. Nat. Sc., 1871, p. 115.

In addition to the molars of the lower jaw, described by Dr. Leidy, we have what corresponds to the third and fourth premolars of the fox, their dental formulæ being probably the same.

The third premolar is small and pointed, differing from the corresponding tooth in the fox, (1) in its being less compressed, (2) in its shorter antero-posterior diameter, (3) in thes traighter and more nearly equal margins, and in (4) the absence of a posterior heel.

The tooth is inserted by two fangs, as in *Canis* and *Hyænodon*. The posterior shows a rudiment of a third, which is connate with its entire length above the alveolus. There is an indistinct cingulum around the entire crown.

The fourth premolar has a very curious shape. The blade of this tooth resembles the crown of the third, but is smaller. It is inserted by three fangs, the disposition of which is opposite to that in *Canis*, the internal, being on the same transverse line as the posterior external, instead of the anterior, as in *Canis*. From the internal fang arises a sharp cusp, which is nearly as large as the blade of the tooth, the two are connate at base. The anterior face of the crown is much worn, and there is a small anterior heel formed by the basal ridge. The cingulum is complete all around.

The *maxillary* does not show the outward bulge at the third premolar, which is so marked in the fox. The alveolus is straighter, and the palatine plates are comparatively thicker and flatter. The infraorbital foramen is oval, and not so much compressed as in the fox, to which it corresponds very nearly in position, though situated slightly forward as in *Hyænodon*.

Measurements.

Upper Jaw.	M.
Length of third premolar	·007
Breadth of third premolar	·004
Length of fourth premolar	·007
Breadth of fourth premolar	·007
Lower Molars, from Dr. Leidy.	
Length of last premolar	·0075
Length of first molar	·009

These exhibit nearly the same proportionate size as in the gray fox.

Genus ——. *Species* ——.

Sacrum (Plate IX., Fig. 8).—This peculiar sacrum is composed of only one true vertebra; there may have been one or more pseudo-sacrals, but this is not certain.

The centrum is very long, strongly depressed, and straight on the inner margin, not curved as in the sacrum of most mammals. The anterior articular face is much depressed, and is one third larger than the posterior. The neural canal is low and subtriangular, resembling very much that of *Canis*. The pleuropophysial plates for articulation with the ilia are large and stout. The laminæ are heavy and concave on their upper side, supporting a very long, stout spine, which is retroverted and decidedly tuberous at the end.

The pedicles are deeply notched behind; and on the fore part, just inside the metapophyses, there is a deep fossa.

The chief features of this sacrum are decidedly carnivorous; but to what genus or family it should be referred we are unable to say.

It has some of the characteristics of *Canis*, but the length and retroversion of the spine, as well as the size of the centrum, prevent this classification. In the general form of the pleuropophysial plates it approximates to the *seals;* while in its angle and curvature, it partakes of the character of the *Ursidæ*.

The chief point of interest in this fossil centres in the fact that it was found only a few feet from the brain cast that is described below.

Measurements of Sacrum.

	M.
Length of centrum	·031
Long diameter of anterior articular face	·024
Long diameter of posterior articular face	·017
Width of neural canal	·019
Height of neural canal	·011
Length of neural spine	·036
Extreme width of sacrum	·052

MEGENCEPHALON.

MEGENCEPHALON PRIMÆVUS. *Gen. et spec. nov.*

In close proximity to the pelvis of the *Uintatherium Leidianum*, in one of the upper beds we found an intracranial cast, separate from the bone which had enclosed it, and in such preservation as to warrant a partial determination, at least, of the type to which it belonged. Wishing to obtain as full information as the nature of the cast permitted, we put it in the hands of Dr. Spitzka, of New York, who kindly undertook an examination, and sent us the following as the result:

"SIR: The specimen submitted to me is the intracranial cast of some species of Placental Mammals. The cranium had been subject to the influences of the atmosphere, etc., for a considerable period preceding the formation of the cast, and therefore the cast reflects the sutural dislocations which occurred in consequence. The base of the brain cast it is not advisable to attempt to expose, on account of the treacherous nature of the material. The convolutions corresponding to the internal aspect of the *Os temporale* have not been clearly demarcated by the bone surface. The two narrow eminences on it are casts of the grooves of the middle meningeal arteries. The convolutions of the occipital surface had been well marked, but somewhat obliterated through denudation, etc. The important region bordering on each side of the median fissure, and corresponding to the fronto-parietal suture, is unfortunately as good as destroyed; and with this destruction the key to the interpretation of the specimen is lost. However, this much can be stated with absolute certainty, that the frontal region is sufficiently well preserved to state that its convolutions do not correspond to those of the brain of the tapir, rhinoceros, hippopotamus, elephant, pig, horse, hyrax, manatus, or any ruminant or cetacean.

"They also differ in important particulars from those of the *Canidæ*, differ less from those of the *Felidæ*, still less from the *Ursidæ*, although corresponding to none of them. The outline of the cerebral cast is found in two living animals—the marine otter and the seal. But in the seal the gyri show the transverse interrupting series of sulci, characteristic of extreme brachycephaly; and it therefore cannot belong to any animal corresponding to the seal.

"The sea otter's convolutional details are unknown to me, and I believe have not yet been studied. I therefore content myself with stating that the outline of this cast corresponds to the outline of the sea otter's cranium.

"It would help us a great deal if we could decide the existence or non-existence of a bony tentorium. The sutures of this cranium, as far as I can reconstruct them, ran as in the diagram.

"We may state definitely that this was not an ursine, feline, or canine brain, nor the brain of any terrestrial viverrine. It is an open question between an *aquatic carnivore* and an *aquatic pachyderm;* and although not placing my conclusion on an exact basis, yet, in view of the general outline, the course of the convolutions, and the course of the sutures, I incline to the former view.

"It certainly corresponds to no known brain of a living creature. In one point I was inclined to suspect it to be a pachyderm, namely, the decided assymmetry of some of the sulci, but this, by itself, is not decisive."

"DR. SPITZKA.

"308 East 123d street."

The interesting letter quoted in full above, contains as near a determination of the character of the animal to which the brain belonged, as the nature of the cast and the materials for comparison would permit. In a later report, by means of more complete comparative material, we hope to be able to reach a more satisfactory conclusion. However, as Dr. Spitzka writes, the *general outline*, the *course* of the *convolutions*, and the *line* of the *sutures* offer strong presumptive evidence that the cast belongs to one of the *Aquatic carnivores.* Not far from the brain was found a sacrum, which is described above as belonging to some carnivore, though further determination was impossible. Whether there was any connection between the two is difficult to state. The presence of an aquatic carnivore in the Bridger eocene is new to science ; but, aside from this, the brain is of a much higher order than previous discoveries would lead us to expect in such an early formation.

Professor Marsh's researches have led him to form the opinion that the eocene mammals had brains of a low character; but this specimen shows that this is not true of all, if it is of most of them. The convolutions are not only numerous and well marked, but they are complicated, showing the transverse as well as the longitudinal folds. To such an extent is this true that the brain will bear comparison with the very highest modern carnivorous types.

We hope to be able to give further notes upon this interesting specimen at a later date.

PERISSODACTYLA.

ANCHITHERIUM.

Von Meyer, Jahrbuch für Mineralogie, 1844, p. 298.

ANCHITHERIUM— ?

A small calcaneum and astragalus of equine type are provisionally referred to this genus until further material enables us to determine them with certainty.

The *astragalus* has narrow and very oblique condyles, which are more equal in size than in *Orohippus;* the neck is very short, the internal condyle reaching to the face for the navicular; the posterior projection of this condyle is much shorter than in that genus. The articular face for the navicular is quadrate in shape and concave; the cuboid face is very narrow. The articulation with the calcaneum is made by a narrow, convex face. When the two are in position the navicular face of the astragalus is in the same horizontal line as the cuboid face of the calcaneum, thus resembling the arrangement of the horse's tarsus rather than that of *Orohippus.*

The *calcaneum* is a short, slender bone, having the upper and lower margins convergent toward the tuberosity, and not parallel as in *Orohippus.* The tuberosity is especially small. The face for the cuboid is very narrow.

From the articular facets of these two bones we can see that the tarsus resembled very much that of the modern horse, with a broad, short navicular, and a narrow cuboid. The strata in which these remains were found were somewhat higher than those containing the bones of *Orohippus.*

Measurements.

	M.
Greatest length of astragalus	0·021
Greatest breadth of ditto	·018
Length of neck of ditto	·005
Width between the condyles	·010
Vertical diameter of face for navicular	·012
Tranverse diameter of ditto	·012
Length of calcaneum	·046
Width of face for cuboid	·006

From Henry's Fork.

OROHIPPUS, Marsh.

Am. Jour. Sc. vol iv., p. 207, third series.

Generic Characteristics.—"The crowns of the upper true molars are composed of a pair of external cusps similar to those of anchitherium. There are two coresponding inner tubercles, from which ridges extend obliquely to the anterior inner margin of the outer cusps; but the anterior ridge is divided so as to form an intermediate anterior tubercle. All the teeth preserved have a distinct basal ridge."

Species Known.—

OROHIPPUS PUMILUS, Marsh.
OROHIPPUS MAJOR, Marsh.
OROHIPPUS AGILIS, Marsh.
OROHIPPUS GRACILIS, Marsh.

OROHIPPUS PUMILUS? Marsh.

Specimen obtained. Penultimate and third superior molars, with part of zygoma.

From CottonwoodCreek.

OROHIPPUS MAJOR? Marsh.

Femur (Plate IX., Fig. 1).—The femur has a small, nearly hemispherical head, developed on a long and slender neck; the head is but slightly out of the axis of the shaft, and has a large pit for ligamentous insertion. The shaft is long, simple, and curved slightly forward. At the proximal end it is broad and flattened axially; below this it becomes expanded fore and aft, but it thickens greatly at the distal end, just above the condyles. The great trochanter is large and retroverted, rising above the head, with two prominences rising from it, one on top, the other back. The digital fossa is wide and deep, penetrating far into the great trochanter. The second trochanter is a small rounded ridge; the third trochanter is large and prominent, curving slightly forward. The condyles are long and narrow, projecting very far back, and are separated by a wide and deep popliteal groove. From the external condyle a low ridge runs obliquely, forming the upper border of the shallow popliteal space. The trochleæ are long, very convex, deeply grooved, and symmetrical.

Measurements of Femur.

	M.
Width between head and great trochanter	·019
Width at third trochanter	·034
Diameter of head	·019
Width at condyles	·028
Width of trochlea	·015
Height of great trochanter	·015
Diameter fore-and-aft of shaft at middle	·018

The *tibia* (Plate IX. Fig., 3) is very long and heavy, with broad proximal articular face, the inner borders of which are prolonged upward and separated by a groove.

The shaft at the tuberosity is subtriangular, with strongly concave sides. The tuberosity is prominent, with a deep pit on its upper surface for the insertion of the ligament of the patella. The shaft below becomes sub-cylindrical, and decreases regularly in size downward. Its curvature is forward. The distal articular face is divided by a smooth ridge into two deep facets. The malleolus is long.

The *fibula* (Plate IX., Fig. 2) is distinct, straight, and very slender. The distal end is but slightly expanded, and is strongly marked by a vertical groove externally. The proximal end articulates with the overhanging portion of the proximal face of the tibia.

Measurements of Tibia.

TIBIA.

	M.
Length	·178
Width of proximal surfaces (transverse)	·032

Width of proximal surfaces (antero-posterior)	·019
Transverse diameter of shaft	·022
Antero-posterior diameter of distal articulation	·018
Transverse diameter of distal articulation	·018

The tarsus.—The *astragalus* (Plate IX., Fig. 5) has the condyles asymmetrical and divided by a deep groove; the head is narrow, with the neck elongate. The face for the cuboid is small, and confined to the external border.

The *calcaneum* (Plate IX., Fig. 4) is long and compressed, with its upper and lower margins straight and nearly parallel; its tuberosity is large. The face for the cuboid is small.

The *navicular* (Plate IX., Fig. 6) is proportionately longer and narrower than it is in the modern horse. The internal and middle cuneiforms were probably separate.

Metatarsals (Plate IX., Fig. 7).—Three in number. Are very much shorter proportionately than in the modern horse. In shape they are compressed and arched forward. The distal ends are flattened vertically, arched forward, and deeply grooved in the middle.

The *phalanges* (Plate IX., Fig. 7) are very short, rather stout, and very smooth and convex above.

The ungual phalanges are very thin and crescent shaped.

Measurements.

ASTRAGALUS.

	M.
Greatest width	·029
Greatest length	·022
Length of navicular facet	·017
Width of navicular facet	·012
Length of tibial trochleæ externally	·016

CALCANEUM.

	M.
Total length	·058
Total width	·019
Depth in front	·022
Length of heel	·035
Depth of heel	·018
Length of cuboid facet	·014

NAVICULAR.

	M.
Width	·019
Length	·010

PHALANGES.

	M.
Length of first phalanx	·022
Width of first phalanx	·012
Length of second phalanx	·013
Width of second phalanx	·010
Length of ungual phalanx	·005
Width of ungual phalanx	·010

PALÆOSYOPS, Leidy.

Hayden's Geological Survey of Montana, 1871.—Proceedings Academy Natural Sciences, Philadelphia, 1871, p. 118.—*Limnohyus.*—Marsh, American Journal Science and Arts, 1872, p. 124.

Generic characters.—The dentition is full, I. 3, C. 1, Pm. 4, M. 3; the same in lower jaw. The internal cones of the superior molars isolated from the crescentoid crests. One inner tubercle on the last three premolars. One internal cone on the last superior molar. In lower jaw, true molars with four acute tubercles alternating in pairs and connected by oblique crests. The last molar adds a fifth posterior tubercle. The last premolar lacks the posterior inner tubercle. The canines are in continuity with the incisors.

A broad, triangular forehead. A wide zygoma. Long, projecting nasals. Large temporal fossæ. High sagittal crest. Prominent and nearly vertical occiput.

PALÆOSYOPS MAJOR, Leidy.

Survey of Wyoming, 1871, p. 359.—*Limnohyus robustus.*—Marsh, American Journal Science and Arts, 1872, p. 124.

Specific characters.—Sagittal crest short and thick. Temporal fossæ not very deep. Frontals diverge rapidly. Occipital condyles wide and low; the same is true of the foramen magnum. Meatus auditorius high and deep. Glenoid cavity shallow; no internal process. As compared with *P. Paludosus,* post-glenoid process not so much compressed. Occipital region comparatively higher and not so concave. The occipital condyles are more prominent. The zygomas are lighter. Head larger than *Paludosus,* perhaps not so large as *Vallidens.*

Description from (1) a head, complete, but distorted, with complete dentition, upper and lower. (2) A head somewhat crushed, and lacking some portions, with full set of upper molars and canines. (3) A great number of fragmentary specimens of different parts of the body.

Dentition.—In the upper jaw the *incisors* are arranged in a semi-circle as in *P. paludosus ;* they have long fangs and short, conical crowns, with a decided basal ridge, which is very strong in the third. They increase from first to third, which is very large and pointed.

The *canines* have very large and long fangs (longer than the crowns). The crowns are very stout and pointed, constituting formidable weapons. In section they are nearly circular, with a distinct hinder margin and a slight recurve. A rudimentary anterior margin is sometimes present, and of the faces thus marked off, the inner is much smaller and flatter. The general direction is forwards, downwards, and slightly outwards. There is a diastema of about half an inch between the incisors and canines.

Premolars.—The first is very small, about half an inch from the canine, simple and conical, with an obscurely marked basal ridge, and two heavy fangs.

Further description of the upper dentition is unnecessary, owing to the complete work of Dr. Leidy upon the subject.

The *lower incisors* are placed in a semi-circular row, and are somewhat procumbent, though hardly as much so as in the tapir. They are much as in *P. paludosus*, but are relatively smaller, and have not such distinct basal ridges ; features which indicate a departure from the carnivorous type, and a nearer approach to the herbivorous type. The lateral incisor, though the largest of the series, is not so large nor so pointed as in *P. paludosus*. There is no diastema.

The *canines* are about equal in size to those of the upper jaw, growing from stout fangs and permanent pulps. The margins of the crowns are more decided, and are smooth, leaving a very narrow and flat inner face. A feeble basal ridge. When the jaw was closed, the lower canines passed inside and in front of the upper.

The *first premolar* stands immediately behind the canine, is longer than that of the upper jaw, consisting of a single pointed lobe implanted by one fang, slightly recurved with a flat inner and convex outer face. Passing in front of the first upper premolar, it leaves a considerable diastema between this and the second premolar.

The *mandible* approximates in form that of the tapir; the lower border is less curved fore and aft, the alveolar border is slightly concave antero-posteriorly. The molars converge in front, presenting a very different arrangement from that in *Sus*. The ramus is heavy, contracting in depth forward, and very slightly in section. Below the alveolus, on the interior side, the ramus is greatly swollen for two thirds of its depth, to accommodate the very long and strong molar fangs.

The rami converge to the second premolar, where they expand laterally to the canine alveolus. The symphysis is shorter relatively than in *P. paludosus*, and the chin is regularly rounded in front. The mental foramen is below the second premolar. The dental foramen is small, very high up, and far behind the molars. The alveolar border ascends rapidly behind the last molar, expanding laterally into two ridges.

The coronoid is slender and recurved. The condyle is broad, flat behind, inclines forward internally; there is scarcely any depression between the condyle and the coronoid. The masseteric fossa is very wide and deep. The angle of the ramus is broken, but evidently has no such posterior extension as in *P. paludosus*. It thins out rapidly behind.

Measurements.

	P. pal.	P. major.
UPPER JAW.	M.	M.
Length of entire molar series	·147	·170
Length of three true molars	085	·102
Length of three premolars	·058	·068
Diameter of last molar, transverse	·039	·047
Diameter of last molar, antero-posterior	·036	·036
Diameter of second molar, transverse	·036	·040
Diameter of second molar, antero-posterior	·033	·036
Length of incisor series	....	·075
Fore-and-aft diameter of canine at base	·016	·021
Length of crown of canine	....	·033
Diastema between canines and incisors	....	·013
Diastema between canines and molars	....	·010

	P. pal.	P. major.
LOWER JAW.	M.	M.
Incisor series	....	·073
Median incisor fang, length	....	·034
Median incisor crown, length	....	·012
Diameter of median incisor crown, transverse	....	·009
Diameter of lateral incisor crown, transverse	....	·011
Diameter of lateral incisor crown, antero-posterior	....	·012
Length of fang of canine	·055	·052
Extreme breadth of fang of canine	·023	·024
Crown of canine, length	....	·034
Crown of canine, fore-and-aft diameter at base	·019	·021
Diameter of first premolar, antero-posterior	·015	·010
Diameter of first premolar, transverse	·009	·007
Diastema between first and second premolars	....	·014
Length of entire molar series	·164	·186
Length of molar series, omitting first premolar	·132	·163
Diameter of last molar, antero-posterior	·017	·050
Diameter of last molar, transverse	....	·027
Depth of jaw below last molar	·068	·075

Among other specimens obtained at the divide between Henry's Fork and Cottonwood Creek, was a nearly complete but somewhat shattered skeleton of a *Palæosyops major*, found contiguous to the head of the same, parts of which are just described. Portions of these are figured on a one fourth scale in Plate II. The description is from a nearly perfect atlas and axis, several cervical, dorsal, and lumbar vertebræ, more or less complete, and a portion of the sacrum and pelvis, in addition to several bones of the limbs.

The *atlas* has a broad inferior arch, contracted antero-posteriorly, and deeply notched for the prominent odontoid of the axis. The heavy superior arch, inclosing a large and depressed neural canal, is capped by a low tuberosity. It slopes into a flat, and very broad transverse process, which thickens backwards, and is perforated by the vertebraterial canal. Forwards the transverse process is notched for the exit of the first spinal nerve. The anterior or condylar faces are continuous, deeply concave from above downwards; and slightly so from side to side; while the posterior faces are oval, nearly flat, and directed backwards and inwards.

The *axis* is proportionately small, with a long opisthocœlous centrum, depressed, and produced forwards into a stout conical odontoid process, and marked below by a strong hypapophysial keel, which, developed on the latter half, thickens backwards. The wide and thin pedicles inclose a high neural canal, support the posterior zygapophyses and a prominent and peculiar neural spine. The latter is flattened, broad, and recurved posteriorly, thinning rapidly forwards into a prow-shaped recurved edge. The transverse processes arising from the latter half of the centrum are undersized and widely perforated at base. The anterior faces are very broad, directed outwards, and slightly rounded from above downwards; they expand as they diverge (see Fig. 2). The post-zygapophyses are small convex faces, projecting at the base of the neural spine.

The *remaining cervicals*, five in number, are short, all carinate, except the seventh, and opisthocœlous; with the faces expanding only slightly beyond the body of the centrum. A peculiar feature is a small pit upon the convex anterior face, indicating either a ligamentous attachment with the antecedent vertebra, or a remnant of the notochord. This is a feature we have not noticed elsewhere. A long and heavy transverse process supports a large and widely-perforated inferior lamella. The pedicles are quite wide at base, inclosing a large neural canal. The entire upper part of the arch is unfortunately wanting.

The *dorsal* centra are smaller than the cervical, slightly opisthocœlous, and carinate. They are sub-cylindrical anteriorly, with decided costal surfaces before and behind; approaching the lumbar region they become sub-triangular. A high neural arch supports a stout, but never very high neural spine; this projects backwards, keeled in front, expanding and deeply grooved behind. The zygapophyses are small and nearly vertical. There is a short and thick transverse process.

The *lumbar* vertebræ are long, decidedly opisthocœlous, becoming wider and more depressed as they approach the sacrum. The first *sacral* vertebra presents the same characteristics as the last lumbar, only the body of the centrum is slightly shorter. It has a very broad pleuropophysial plate. The remaining sacral vertebræ are broad, and very greatly depressed, rapidly decreasing in size. The transverse processes are slender. The very low neural spines anchylose into a long ridge. The number cannot be ascertained, owing to the fragmentary state of the sacrum. The caudals indicate a tail of not very great length; as the neural canal is small and persists in only a few of the anterior vertebræ.

Measurements of Vertebræ.

	Pal. major. M.
Atlas, width, including transverse processes	·195
Atlas, length of inferior arch	·082
Atlas, height, including superior and inferior arches	·078
Axis, width, anterior articular faces	·110
Axis, length, excluding odontoid process	·058
Axis, height of neural spine	·096
Axis, length of odontoid process	·025
Seventh cervical, length of centrum	·037
Seventh cervical, width of posterior face	·043
Dorsals, anterior region, length	·038
Dorsals, anterior region, width, articular face	·034
Lumbar, width of posterior face	·058
Lumbar, length of centrum	·056
First sacral, width of anterior face	·059

The ribs, of which great quantities of fragments remain, were slender and not of very great width.

The *femur*, which is figured in Plate I., has a small head, supported by a short neck. The shaft, very broad below the head, supports the third trochanter one third of the way down; below which it takes a cylindrical form, and expands slightly above the trochlea. The two condyles, separated by a wide and deep popliteal groove, are nearly sub-equal in size—the internal somewhat the larger, while the trochlea is long, narrow, and symmetrical. The great trochanter rises slightly above the head, and overhangs a long and quite deep digital fossa. The second trochanter is small. The popliteal space is slightly concave.

Tibia.—The proximal end of the tibia is very large, with massive rugosities for muscular attachment. The two proximal faces are sub-equal, slightly convex, and separated by a prominent spine, which is grooved at the top. The shaft is long, straight, and compressed antero-posteriorly; the anterior ridge on upper third is very high, and expands into the tuberosity, which is enormous; while on the posterior face is a deep fossa just below the head. The distal end of the shaft is remarkably small, with two concave faces—the internal the smallest—with a low oblique ridge dividing them. There is a prominent malleolus.

The fibula (which is a distinct bone) has a small proximal end, and expands slightly below, with a large external malleolus.

Measurements of Limbs.

	M.
Femur, total length	·420
Femur, transverse diameter at distal end	·098
Tibia, length	·310
Tibia, transverse diameter, proximal articular face	·090
Tibia, transverse diameter, distal articular face	·077

The *pelvis* is described from the right and left ilia, which are broken as they expand towards the crest; the acetabulum is fragmentary, but all the parts remain. The ischium and pubis are only represented by fragments. As figured in Plate V., the acetabulum is restored from a somewhat smaller specimen. The most striking feature of the *ilium* is the long and somewhat constricted neck. The acetabular border is long and curved forward, thinning gradually as it approaches the crest; and marked on the iliac surface, near the acetabulum, by a slight rugosity for the rectus muscle.

The ischial border, while less arched, is probably longer; and the sacral surface, distinctly defined, indicates that the rounded upper border of the ilium rarely reached above the sacral spines. There is a deep groove between the ischial and pubic borders, the latter disappearing about half way up the iliac surface. The gluteal surface near the acetabulum is much depressed; aboveit expands into a broad, flat, thin plate

The *ischium* has a stout neck and thick expansion below; the upper border is very heavy. From what remains of the *ischium* and *pubis* we can infer a large elliptical obturator foramen, a short pubic symphysis, a narrow and rather slight pubis, with a small nearly cylindrical neck. The acetabulum is deep, with a thick well-raised border, and a large, oblong, and very deep pit for the ligamentum teres.

Measurements of Pelvis.

	M.
Ilium, transverse diameter above acetabulum	·062
Ilium, long diameter (estimated)	·232
Acetabulum, greatest diameter	·050
Ischium, transverse diameter below acetabulum	·041
Pubis, diameter at obturator foramen	·035

The *tarsus* is arranged in the usual Perissodactyle order. The *calcaneum* is stout, of good length, tuberous, but not expanding much at the extremity; presenting two faces for the astragalus, of which the internal is the largest, and a large distal face for the cuboid. The *astragalus* is wide, with less asymmetry in the two articular facets than is common. It articulates with both the cuboid and navicular.

Measurements of Tarsus.

	M.
Astragalus, total width, tibial facets	·048
Astragalus, total length	·056
Astragalus, length, navicular facet	·046
Astragalus, width, navicular facet	·035
Calcaneum, total length	·120
Calcaneum, total breadth	·057
Calcaneum, length of tuber calcis	·050

All the above were found at Henry's Fork Divide. In another locality, in connection with a fine head of *P. major*, was found the lower half of a *humerus*.

The *shaft* is cylindrical and twisted, expanding widely at the distal end. Of the two condyles the external is the largest; and, to quote from Dr. Leidy, "a deep supracondylar fossa occupies the front of the humerus, opposed by a deeper and more capacious anconeal fossa." The greatest breadth between the supracondyloid eminences is ·091 m.

PALÆOSYOPS PALUDOSUS, Leidy.

Cont. to Ext. Vert. Faun, *P. lævidens* Cope. U. S. Geol. Survey of Terrs, 1872, p. 591.

Specific characters.—Second superior molar has but one outer tubercle. The cones are low as compared with *P. ma-*

jor. The cingula are much less developed. The angle of the lower ramus is much longer. The zygoma is massive and wide. An internal process on the glenoid cavity. Temporal fossæ very deep. Crest of occiput nearly in same vertical line as occipital condyles.

The full details of *P. paludosus*, which follow, may seem somewhat unnecessary, to one familiar with the comprehensive work of Dr. Leidy upon the subject. Care has been taken not to retrace any of his steps; and the descriptions given below are of those parts of the animal which he did not possess at the time of writing. They include (1) a cranium perfect posterior to the orbits; (2) a right *ramus* mandibuli, with full dentition, except the first premolar; (3) portions of the fore-limbs, scapula, and pelvis, pes and manus, and many fragments of other parts.

Among the first discoveries on Cottonwood Creek, in a stratum of fine green sand, was a head of *P. paludosus*, complete posteriorly, and broken off just behind the orbit. A rear view of this has been admirably figured in Plate I.

General appearance.—The base of the cranium is of great width; the occiput is high, inclined very slightly backwards, and deeply concave from side to side. The forehead is triangular and narrow. The temporal fossa is of immense size and depth, leaving a small intracranial cavity. The zygomas are heavy, and arching widely outwards give this part of the head a strong resemblance to the *Felidæ.*

Description in detail.—The narrow but prominent *basi-occipital* segment is broadest posteriorly and tapers forwards; divided by a median ridge, which expands anteriorly into a large tuberosity; a feature also characteristic of the tapir. About half an inch in advance of the condyles are the condylar foramina. The *condyles* are formed of the ex-occipitals, which are low and of great lateral expansion. Their junction with the mastoids is marked by a large foramen. The *par-occipitals* are short and styliform. The *supra-occipital* region is very large, high, and deeply concave from side to side, much wider than in the tapir, with a marked interparietal suture. The *condyles* are wide, but not very deep, approaching each other very closely below. The *basisphenoids* are long and narrow, tapering forwards. The *alisphenoids* are mutilated, but indicate large vertical ridges joining the parietals, and heavy pterygoid processes, perforated at the base by the alisphenoid canal. They are again perforated by the foramen ovale three fourths of an inch behind this. This completes the base of the skull.

The *parietals* are very large, they form nearly the whole of the temporal fossæ; which, deep and wide, enclosing a small cranial cavity, contrast strongly with the long and shallow temporal fossæ of the tapir. The parietal crest is very broad, and grooved at the top. This high crest and deep adjacent temporal fossæ we at first mistook as pointing to an exclusively carnivorous type. The forehead has a triangular appearance, from the divergence of the two side ridges of the sagittal crest. The *postorbital* processes are very large, but do not reach the opposing processes of the *malar*. The orbit is thus left incomplete posteriorly, while in form it greatly resembles that of the *Sus*. The *squamosal* encroaches considerably upon the temporal; and sends outwards and downwards a great zygomatic process, which arches outwards from the skull as in the *Felidæ*, and is more powerful than in any living carnivore (Leidy.) A strong downward direction is especially characteristic, the whole describing a sigmoid curve. The *mastoids* are of great size vertically, and transversely they are confluent with the paroccipitals. A low, thick process on the internal side of the glenoid cavity prevents lateral motion.

The *nasals* are long, broad, and thick, convex from side to side, narrowing slightly anteriorly. They are straight, as in *Sus*, which they rèsemble more than they do either tapir or rhinoceros. The anterior borders are rounded, and do not reach as far forward as the symphysis of the premaxillary. The *malar* is broad and thick, probably forming but little of the face, being directed downwards and backwards to meet the zygoma. The postorbital process is short, and rather larger than Dr. Leidy has indicated. The *maxillaries*, smaller proportionately than in *Sus*, form posteriorly the floor of the orbit; while the infraorbital foramen is situated over the last premolar. The premaxillaries fail to reach the nasals.

Comparative Measurements of Head.

	P. paludosus.	P. major.	Tapir.
	M.	M.	M.
Height of occiput	·122	·148	·120
Breadth of occiput at post tympanic processes	·160	·166	·110
Breadth of cranium at ends of post-glenoid processes	·172	·210	·126
Transverse diameter of occipital foramen	·031	·049	·040
Vertical diameter of occipital foramen	·027	·033	·027
Depth of occiptal condyles	·033	·039	·029
Breadth of occiptal condyles	·040	·049	·041
Breadth at occipital condyles together	·082	·100	·082
Width of basi-occipital at anterior condyloid foramina	·038	·039	·028
Width of basi-occipital at junction with basi-sphenoid	·025	·032	·020
Width of crest dividing the temporal fossæ posteriorly	·011	·020	·011
Breadth of cranium outside of zygomata	·262	·280	·180
Depth of zygoma	·046	....	·036

Lower jaw of *P. paludosus* described from another specimen.

The peculiar feature of this jaw is its remarkable extension back of the molar series (a feature which has not been noticed heretofore), the distance from the last tooth to the angle being greater than the length of the entire molar series. From beneath the last molar, the lower margin curves gently up to the symphysis. The alveolar border is but slightly curved. Behind the last molar the lower margin forms a sigmoid curve, much more decided than in *P. major* (first upwards and then downwards), and the ramus thins out rapidly to the angle, where it has a slightly raised border; at the diastema the ramus curves outwards so as to throw the canines out of the line of the molars. The symphysis is long.

Dentition.—The *incisors*, three in number, from length and shape indicate a semicircular arrangement, as in most Perissodactyles. They increase from first to third. The crown of the first resembles very much that of the ruminants, but has a straight posterior basal ridge. Its forward edge is worn so as to expose a small tract of dentine. The second is larger, but very much like the first in conformation; while the third has an acute conical crown with a strong basal ridge.

Of the *premolars* the first is wanting in this specimen. The second is bilobed, the anterior lobe much the larger. It has a small accessory tubercle on its anterior slope. The outer face is rounded, the inner nearly flat. The posterior lobe is very small and obtuse, and with the inner face slightly grooved. In third and fourth the valley between the lobes and the groove on their faces enlarge; while the anterior lobe becomes relatively smaller.

Measurements of Lower Jaw.

	M.
Diastema between canine and first premolar	·024
Length of entire molar series	·143
Distance between last molar and extremity of angle	·147
Depth of jaw at last molar	·070

Among the first discoveries on Cottonwood Creek, in connection with the lower jaw of *P. paludosus* just described, were an ulna and radius, and part of the manus and scapula of the same. These have been figured, together with other fragments belonging to the same species, in Plate III., and form an interesting complement to the nearly complete hind limb of *P. major* previously described.

The *scapula* has a shallow oval glenoid cavity, which is concave longitudinally. Separated from it by a narrow notch is a strongly recurved coracoid, placed on the inner side of the bone. Above the coracoid the border is thin, and arches inwards and then forwards; while the glenoid border is much straighter, rising from a slight tuberosity. The spine rises gradually from the glenoid, and does not bear any indication of an acromion.

The *humerus* is represented by proximal and distal extremities. The latter presents the same characters on a smaller scale as in *P. major*. Upon the proximal end there is a deep bicipital groove. The greater tuberosity has a hooked anterior projection, and runs back into a ridge behind. (See Fig 7, Plate III.)

The proximal end of the *ulna* (of median breadth anteriorly) narrows into a prominent ridge behind. This gives a trihedral character to the shaft. This is persistent, but is less marked as the fore-and-aft diameter decreases. The remaining features of note are a high tuberous olecranon expanding behind; a shallow sigmoid, divided by a deep fossa into two long divergent articular faces; a trihedral shaft tapering slightly, but distinct from the radius; a narrow distal extremity, with a small irregular face for the cuneiform.

The *radius* has a rather short shaft, curved forwards, expanding below, and placed immediately in front of the ulna. A strong ridge runs from the external tuberosity up the posterior face of the shaft, disappearing two inches from the top. The proximal end, fitting against the ulna by two small faces, forms the greater part of the elbow-joint, a strong median ridge dividing the proximal face into two subequal surfaces with well-raised borders. The distal end of the shaft is rugose, and more prominent than the proximal. It has an oblong transverse face, which is slightly concave fore and aft. The position of the radius, immediately in front of the ulna, and its manner of articulation, remove any possibility of rotation, a feature in strong contrast with what we should expect from the character of the head.

Measurements of Ulna and Radius.

	M.
Ulna, length, excluding olecranon	·224
Ulna, length of olecranon	·080
Ulna, transverse diameter, proximal surfaces	·041
Ulna, diameter of shaft at median line	·038
Ulna, fore-and-aft diameter, distal face	·025
Ulna, transverse diameter, distal face	·017
Radius, proximal face, transverse	·048
Radius, proximal face, fore and aft	·030
Radius, median diameter, shaft	·019
Radius, median diameter distal face, transverse	·043
Radius, median diameter distal face, fore and aft	·016

The *manus* is described from the third and fourth metatarsals, with three phalanges. The metatarsals are short, with a wide, stout shaft, flat in front and slightly arched forwards behind. The proximal ends unite and form a continuous articular face, concave from side to side; while upon the exposed sides are smooth facets, indicating the presence of two additional toes of less size. (See Plate III.) The convex distal faces are marked behind by a slight groove.

The *phalanges* are very short and broad, the lower facets marked by a shallow median groove. The ungual phalanx is wide and short, with a crescentic outline.

Measurements.

	M.
Third metatarsal, total length	·090
Third metatarsal, transverse diameter, proximal face	·017
Third metatarsal, transverse diameter, distal end	·019
Second phalanx, length	·024
Third phalanx	·014
Total estimated length of manus (6 inches)	·155

PALÆOSYOPS VALLIDENS, Cope.

Proceedings Am. Phil. Society, 1872, p. 487; Hayden's Survey, 1872, p. 572.

Specific characters.—Founded on details of dental structure. Superior size. In the upper molars two strong transverse ridges connect the inner tubercle with the outer crescents, inclosing a pit between them. In the premolars the outer crescents fuse almost into a single ridge. These united crescents are relatively narrower. The inner molars are also narrower, and the posterior tubercle of the last is an elevated cone.

Fragment of a lower jaw containing the two posterior molars. The measurements of the teeth are identical with those given by Professor Cope. The depth of the ramus below the last molar is three and one third inches, and it is slightly heavier below than in *P. major*.

Restoration of Palæosyops.—The elevation of *Palæosyops major*, which is taken as a type, was approximately the same as that of *Palæotherium magnum* as restored by Cuvier.

The nearly complete ilium, femur, tibia, and tarsus of *P. major* in our possession, enable us to make the following estimate of the elevation of the hind quarters.

	INCHES.
Pelvis, height of ilium above acetabulum..........................	9
Femur and *tibia* by actual measurement, allowing for bend at the knee.	26
Tarsus, from astragalus, and cuboid....	3
Metatarsus and *phalanges* (estimated from manus of *P. paludosus*.....	8
	46

It is probable that the fore-shoulders were of the same height. From the atlas, axis, and from other cervicals, several dorso-lumbar vertebræ, and part of the sacrum, a rude estimate places the length of the animal at sixty-seven inches, or nearly six feet, including the head, and excluding the tail.

In general features it strongly resembled the tapir, with stout body, slender tail, and very short neck, compensated by a proboscis of considerable length. In comparing the heads of the ancient and modern representatives of this class of Perissodactyles, the points of contrast are the wide stout zygomas, the deep temporal fossæ, the protruding nasals, and the narrow gaps in the dental series of the older type.

There are also strong points of resemblance in the structure of the *Palæosyops* and *Palæothere*. Some of the cranial homologues have been detailed by Dr. Leidy. The femur of the Palæothere is shorter, the tibia longer; they are both much stouter. The tarsus of the *Palæosyops* is narrower, while the remainder of the Pes is very similar. The pelvis, and particularly the ilium and acetabulum of *Palæosyops*, is more palæotheroid than tapiroid. The similarity of the fore-shoulder in the two types is also striking. The neck of the *Palæosyops* was probably shorter.

In the descending series of *Palæotheres* terminating in the diminutive *P. minus*, and characteristic of the upper eocene of France, we have an interesting counterpart in the large family of *Palæosyops*, of equal diversity of size and characteristic of our lower eocene, and it is hoped that future discoveries will render a complete discussion of this interesting coincidence possible.

LIMNOHYUS, Leidy.

Proceedings Academy Natural Sciences, Phila., 1872, p. 242; Palæosyops; Marsh, American Journal Sci. and Arts, 1872, p. 122; Hayden's Survey, 1872, p. 592, Cope.

Generic characters.—Resembles *Palæosyops* in general features. Distinction founded on the possession of two conic tubercles, of the inner series, on the last superior molar instead of one.

LIMNOHYUS LATICEPS, Marsh.

Palæosyops Laticeps. Am. Journ. of Sc. v. iv. p. 122.

Specific characters.—" Cranium is broad. The zygomatic arches much expanded. The nasals are narrow and elongated, and more like the corresponding bones in Hyrax than those in the larger pachyderms."

Fragments of the upper molar and premolar series. The species is determined by measurements given by Dr. Leidy of the second upper molar.

LEUROCEPHALUS, *Gen. Nov.*

Established on a specimen having a nearly complete dentition, and portions of the cranium.

Dental Formula: (I. $\frac{3}{3}$, C. $\frac{1}{1}$, Pm. $\frac{4}{4}$, M. $\frac{3}{3}$,) × 2 = 44.

Upper incisors acute, with strong posterior ridges, lower incisors compressed and laniariform , canines compressed, with serrated cutting edges; first upper premolar with rudimentary anterior lobe, last upper molar with rudimentary postero-internal cusp. Molars constructed as in *Palæosyops*, but higher, with sharper cones and more erect external lobes. Internal median valley very much deeper. Little or no depression at the forehead; zygomatic arch round, comparatively straight and does not project outwards, and with obscure postorbital process. Premaxillaries short and straight. Mandible with nearly straight lower margin, and shallow masseteric fossa; mental foramen single.

LEUROCEPHALUS CULTRIDENS, *Sp. Nov.*

This species was considerably larger than *Palæosyops major*, with which it shows affinities, as also with *Titanotherium Proutii.* See Plate IV.

The *Frontal* is narrow and flat, or slightly arched. It sends out a strong curved postorbital process, which projects outwards, but not so much outwards as in *Palæosyops.* The sagittal crest runs back from the postorbital in a low rounded ridge, rising but little as it recedes. The superciliary ridge is distinct, and is pierced by two small venous foramina. The shape of the entire bone is much as we find it in the dog, except that it does not arch so much. One of the most marked differences between this genus and *Palæosyops* is here shown. In the latter the forehead rises abruptly from behind the orbit, while in the former there is only a slight rise for some distance behind the orbit. As the bone is broken here, it is impossible to state whether there is any rise at all. Probably not, however. Below the post-orbital process, on the lateral aspect of the bone, there is a low ridge which separates the orbit from the temporal fossa. The under surface of the frontal is smooth.

The *Nasal*, of which but a small portion is preserved, is flat on top, but bends downward at the angle.

The *Maxillary* is long and stout, over the last and penultimate molars it broadens to form the floor of the orbit, which is of unusual size. Between the canine and the malar the maxillary arches inwards, forming a perceptible concavity, at this point it reaches its greatest vertical height, as it rises to join the nasal. The alveolar border is curved in two directions, one with the convexity outwards, and the other downwards. It exhibits no emargination in the diastema between the canines and molars. The palatine plate is long, thick, and narrow; it is flat fore and aft, but concave transversely, owing to the elevation of the alveolus; the suture also is raised slightly. In thickness it varies; being thickest between the canine and the second premolar, and beyond this becoming thinner. Its forward termination seems to be obtuse, running for a short distance along the premaxillaries. The infra-orbital foramen is large, situated over the fourth premolar, lower down, and nearer to the malar than in *Palæosyops*.

The *Premaxillary* is rather short and stout; it is slightly compressed, and ends in a sharp keel on top. Although not so thick as in *Palæosyops*, it is much larger vertically. The inner surface is ridged; it has no palatine process, and no spine, so that the incisive foramen is large and undivided. There was no symphysis between the two premaxillaries, they do not show even any articular faces for each other, so that they may not have been in contact during life. The animal was adult, but not old. The incisive alveolus is short and straight, and is but little out of the line of the molars. There is a very long diastema between the incisors and the canine, and here the premaxillary is deeply notched to allow the passage of the lower canine.

The *Malar* is very different in shape and size from the same bone in *Palæosyops*. Its facial extent is greater, as it articulates with the maxillary as far forward as the *first* molar. It is not so broad from above downwards, but is considerably thicker; the articulation with the squamosal is by flat surfaces. The postorbital process is small and indistinct. The orbit is of great size; its breadth, shown by the maxillary floor is unusual, but its fore-and-aft diameter is extreme, being nearly twice as great as in a large *Palæosyops major*.

The *Squamosal* is a short, slender, and trihedral bone; it is not at all like the squamosal of *Palæosyops*. It is smaller even than that of *P. paludosus;* its outer margin is not turned up, making the upper surface concave; it does not project much outward, and scarcely at all downwards, as this is rendered unnecessary by the flatness of the forehead. The chief difference, in the size of this bone, between this genus and *Palæosyops* is found in the much greater vertical and lateral diameter of the latter; in length they are about equal. The glenoid cavity is large, shallow, and transverse.

As a whole, the zygomatic arch is comparatively slender, it is rounded, and does not project much laterally from the side of the head; but its chief peculiarity consists in the fact that it is nearly horizontal. It is thus altogether different from the arch of *Palæosyops*.

The *Occipital Condyles* are different from those of that genus. They are flatter, shorter from above downwards, and proportionately much smaller; but are expanded laterally in much the same manner. At the border of the foramen magnum they are gently rounded instead of having a sharp angle. These borders are segments of circles, but as the condyles are broken from the rest of the occiput, we cannot infer from this the shape of the foramen.

The *Mandible* is long, stout, but comparatively shallow. It is of nearly uniform thickness throughout, and does not exhibit the thickening of the alveolus and thinning, of the lower margin, which is shown in *Palæosyops*, especially in *P.*

major; and the downward and inward arching of the alveolar border is not marked to the same extent as in that species. The lower border is nearly straight, and has but one slight emargination just behind the symphysis. The ascending portion of the ramus rises near the last molar quite abruptly, and makes an angle of nearly 90° with the horizontal portion. The masseteric fossa is shallow and obscure, and the anterior bounding ridge is almost obsolete. This part of the jaw is very different from any of the species of *Palæosyops.* The symphysis is quite long, and extends back as far as the second premolar; the chin is probably rounded. The dental foramen is situated high up in the ascending portion of the ramus; the mental foramen is placed below the second premolar; it is large and single.

Cranial Measurements.

	M.
Breadth of frontal at postorbital process	·045
Breadth of frontal in front of postorbital	·030
Breadth of nasal just in front of orbit	·032
Length from angle of nares to end of premaxillary	·1235
Length of premaxillary	·056
Length of maxillary	·230
Breadth of palatine process at canine	·026
Breadth of palatine process at second premolar	·029
Vertical height of maxillary at angle of nares	·064
Breadth of maxillary across floor of orbit	·058
Fore-and-aft diameter of orbit	·054
Length of malar along maxillary	·094
Vertical diameter of malar behind maxillary	·029
Transverse diameter of malar behind maxillary	·033
Fore-and-aft diameter of glenoid cavity (about)	·029
Vertical diameter of squamosal at end of malar articulation	·032
Transverse diameter of squamosal at end of malar articulation	·0325
Length of ramus mandibuli from symphysis to ascending portion	·177
Depth of jaw at last molar	·068
Depth of jaw at second premolar	·061

DENTITION.

UPPER JAW.—The *incisors,* three in number, are placed close together in a nearly straight line, which does not make so great an angle with the line of molars as in *Palæosyops.* They increase regularly in size from the first to the third, which is very large. They all have stout rounded fangs, and sharp pyramidal crowns, with strong basal ridges separated from the acute blades by deep clefts. Between the incisors and the canine there is a long diastema.

The *canine* is of great size; it has a swollen fang, and a long recurved crown which is much compressed, and has sharp serrated cutting-edges. The external face is the more convex, the internal has a well-marked basal ridge, and both are longitudinally striated. The canine is separated from the premolars by a short diastema.

Premolars.—The first premolar stands by itself, separated by a short interval from the second. It is implanted by two fangs, and has a compressed crown with sharp cutting-edges. It is nearly twice the size of the corresponding tooth in *Palæosyops*, which is simple and conical. In the specimen under description there is, besides the principal lobe of the tooth, a rudimentary anterior lobe which gives the crown an elongate shape. The basal ridge is shown on the inner side only. The second premolar has a crown which is oval in section. The external part consists of two sharp-pointed cusps, separated by a valley, but confluent at base; while the internal division is a low ridge (not a pointed cone as in *Palæosyops*) with a tubercle developed behind it. The basal ridge is marked all around, and sends up a buttress along the antero-external lobe; as is also the case in the third and fourth premolars. These are enlarged copies of the second; but have the internal lobe elevated into a sharp cone, and showing a much stronger basal ridge and deeper median valley. These teeth differ in several respects from the premolars of *Palæosyops*. The crowns are higher and the lobes sharper; the basal ridge is more distinct, and is not interrupted at the internal cusp; the external ascending buttress is stronger; and there is no fold between the external lobes of the fourth.

The *molars* are constructed in a manner which resembles that of *P. paludosus* rather than of *P. major*, but its resemblance to the form shown in *Titanotherium* is stronger than to either. They have broad, square crowns, which increase progressively in size from first to last. There is a convexity running up the median line of the external lobes, and the two posterior lobes are connected together at their bases. The first molar does not exhibit such a decided increase in size over the last premolar as is seen in *Palæosyops;* the two external lobes are more erect and sharper than in any form of that genus. The cingulum is complete even across the internal cones, and the median valley is very deep, as in *Titanotherium.* There is a conspicuous fold at the junction of the external lobes, and a minute tubercle between the two anterior lobes; this tubercle is present only in the first molar, and not throughout the series, as in *Palæosyops.* The second molar in general form is like the first; but is larger, has a deeper median valley, more conspicuous external folds, and a stronger basal ridge. There is also some change in the proportions of the crown; the first measuring the same in both directions, while the second is wider than it is long. The last molar has but one internal cone; the second is represented by a tubercle; which however is a true rudimentary lobe and not a development of the basal ridge. In this tooth, the external fold is very large and the median valley very deep.

LOWER JAW.—The lower molars and premolars are very much like those of *Palæosyops*, but are longer, narrower, and higher. The *incisors* are not at all like *Palæosyops,* but are compressed and laniariform, with acute crowns and sharp cutting-edges. The canine is not present in our specimen; but that it was large, is shown by the long diastema between the upper canine and incisors.

Premolars.—The first is small, simple, and implanted by a single fang close to the canine. The diastema between it and the second premolar is about one half of that in *P. major.* The second premolar is the most peculiar tooth in the lower series; as it carries the development of the anterior lobe at the expense of the posterior lobe, to a still greater extent than in *Palæosyops*, forming a crown like the blade of the carnivorous sectorial. The third lobe of the last molar is no longer a simple cone, but a functional lobe, with two crests running from it, which bound a median valley.

Teeth Measurements.

UPPER JAW.	M.
Length of entire dental series	·275
Length of incisor series	·0375

Length of diastema between canine and incisors	·018
Fore-and-aft diameter of canine	·019
Transverse diameter of canine	·015
Length of diastema between canine and premolars	·0145
Length of premolar series	·083
Length of first premolar	·016
Width of first premolar	·009
Length of second premolar	·021
Width of second premolar	·017
Length of third premolar	·022
Width of third premolar	·022
Length of fourth premolar	·024
Width of fourth premolar	·027
Length of true molar series	·106
Length of first molar	·031
Width of first molar	·031
Length of second molar	·037
Width of second molar	·040
Length of third molar	·038
Width of third molar	·041

LOWER JAW.	M.
Length of entire molar series	·202
Length of premolar series	·081
Length of true molar series	·121
Length of second premolar	·024
Width of second premolar	·0125
Length of third premolar	·022
Width of third premolar	·014
Length of fourth premolar	·0235
Width of fourth premolar	·0155
Length of first molar	·030
Width of first molar	·017
Length of second molar	·038
Width of second molar	·021
Length of third molar	·053
Width of third molar	·024

Found at Henry's Fork Divide.

This may eventually prove to be a species of *Telmatherium*, (Marsh); but the description given by him of that genus is so brief and uncharacteristic that it might apply to any of the allied genera. Indeed, Dr. Leidy has regarded it as a synonym of *Palæosyops*.

HYRACHYUS, Leidy.

Proc. Ac. Nat. Sc., 1871, p. 229, *et sqq.*

A genus of tapiroid mammals, which is thus defined: "*Lower Jaw:* Third molar with two crests; four premolars, third and fourth with one transverse and one longitudinal crest. *Upper Jaw:* Seven molars, first without interior heel; premolars with two transverse crests." (Cope.)

Synopsis of Species.

I. Long diastema between lower canines and molars.
  A. Lower jaw with six molars................*H. nanus.*
  B. Lower jaw with seven molars.
    a a. Upper molars with complete cingulum. Enamel wrinkled.
    a. The last molar with two external lobes on nearly the same transverse line.......*H. intermedius.*
    b. Last molar with the external lobes on the same longitudinal line................*H. modestus.*
    b b. Upper molars with cingulum incomplete externally.
    a. With anterior conical buttress larger than anterior lobe.
      α. Buttress separate, and no fold from anterior lobe............*H. princeps.*
      β. Buttress united, and quite large fold from anterior lobe.....*H. imperialis.*
    b. With anterior conical buttress smaller than anterior lobe.
      α. Tooth large..............*H. eximius.*
      β. Tooth smaller............*H. agrarius.*
    c c. Cingulum only on outer side of first molar, buttress separated by a ridge from anterior lobe, fold from this lobe very prominent.
    H. implicatus.
II. Short diastema between lower canines and molars.
  A. Descending ridge from antero-external point of lower molar extends entirely across the crown of the tooth anteriorly....................*H. crassidens.*

HYRACHYUS IMPERIALIS, *sp. nov.*

Established on the second and third molars of each upper jaw, and three premolars, and one lower molar, portions of the skull and vertebræ.

This species is, with the exception of *H. princeps*, (Marsh), the largest species of the genus as yet known. It differs from *H. princeps* in the greater proportionate length of the molars, in their larger size, compared with the bulk of the animal, and in the less separation of the anterior external conical buttress. The third molar is the largest; the fold extending from the antero-external lobe into the valley is very conspicuous. The basal ridge (which is very strongly marked on the posterior edge), is very feebly indicated on the exterior. The transverse crests are more oblique in the second than in the third, but in the latter the valley is deeper and the crests slightly longer. The anterior conical buttress is of great size, being larger than the anterior lobe. The premolars have, as usual, one internal cone; the anterior and posterior external lobes approach close together, while the accessory fold from the anterior lobe becomes very prominent, reaching the internal cone and enclosing a valley between itself and the transverse crest. The basal ridge does not extend around the inner part of the crown as in *H. agrarius*.

The only lower molar we have, seems to be a penultimate molar of the right side. The basal ridge is large anteriorly, very short posteriorly, but does not appear at all upon the sides, as in *H. agrarius*.

The remaining bones of the skeleton indicate a rather small animal, the teeth are therefore proportionately very large.

The occipital condyles are small and sessile; they are much extended laterally, and the external angles are pointed. In other respects they resemble the condyles of *Palæosyops*. The zygomatic arch is slender and does not curve outward strongly. We cannot tell how far the malar encroaches upon the face. After leaving the maxillary it becomes much compressed; it has no post-orbital process. The maxillary is of unusual breadth, extends far backwards, and it forms the floor of the large orbit. The mandible is slender and compressed, with a large dental canal.

The atlas is small, and has narrow transverse processes, which are perforated by a large vertebraterial canal. The dorsals have considerably depressed centra, and the ribs are slender.

Measurements.

	M.
Length of last molar	·025
Breadth of last molar	·030
Length of second molar	·024
Width of second molar	·0305
Length of last (?) premolar	·018
Width of last premolar	·0245
Length of second lower molar	·025
Width of second lower molar	·018

From Henry's Fork Divide.

HYRACHYUS INTERMEDIUS, *sp. nov.*

Established on the upper true molar series of the right side.

This species is intermediate in size between *H. agrarius* and *H. modestus*. As in the latter species, the basal ridge extends around the entire crown of the tooth, with a small interruption on the antero-external lobe. It is more pronounced in front and less behind than in *H. imperialis*. The anterior conical buttress is not nearly so well developed as in *H. imperialis*; the valleys are wide, and the descending fold from the antero-external lobe is obscure, scarcely marked at all in the first. The transverse crests are strongly arched forwards, and the anterior is very much the longer. The peculiar feature of the species is the position of the postero-external lobe, which is pushed to the posterior aspect of the tooth; this is carried so far in the last molar that the two external lobes stand on nearly the same transverse line. The antero-external lobe is much the highest point in the tooth, and in the first molar is remarkably sharp. The enamel is considerably wrinkled, but not nearly so much as in *H. modestus*.

Measurements.

	M.
Length of first molar	·012
Breadth of first molar	·0155
Length of second molar	·015
Breadth of second molar	·017
Length of third molar	·0145
Breadth of third molar	·017

From Cottonwood Creek.

HYRACHYUS NANUS, Leidy.

Pr. Ac. Nat. Sc., 1872, 20.

Henry's Fork.

HYRACHYUS AGRARIUS, Leidy.

Pr. Ac. Nat. Sc., 1871, 229.

Henry's Fork.

HYRACHYUS EXIMIUS, Leidy.

Pr. Ac. Nat. Sc., 1871, 229.

Cottonwood Creek.

HYRACHYUS CRASSIDENS, *sp. nov.*

Established on the left and a portion of the right ramus mandibuli, containing the first molar.

The jaw presents some differences from the form common in Hyrachyus. The alveolus is more curved, especially near the ascending portion of the ramus; the jaw is narrower, and is especially contracted near the incisive alveolus. The lower margin of the ramus is but slightly curved. The ramus itself thickens regularly from before backwards, and is thickest at the last molar; beyond which it becomes thinner again. The depth of the jaw is comparatively small, and the teeth have a forward inclination; the mental foramina are not so large as in other species of *Hyrachyus*, and are four in number.

The incisors are small, arranged in a semicircle, and have very much compressed fangs, with somewhat procumbent crowns; the canines are small, and form a continuous series with the incisors. There is a diastema between the canine and first premolar; but one which is shorter than in known species of the genus, and which does not indicate the usual curve of the upper border of the ramus.

The molar series, (so far as can be judged from their broken condition), are much the same as in other species; except, perhaps, in the greater relative size of the posterior lobes, and in the more complete closing of the median valley by the junction of the two lobes externally. The ridge which curves downwards and inwards from the external point of the anterior lobe is unusually well developed, and curves across the entire crown. The cingulum is feebly shown ; it appears on the anterior and posterior ends of the tooth (first molar) and for a very short distance on the outside of the tooth opposite the median valley ; there is no trace of it on the inner side.

Measurements.

	M.
Length of entire molar series (about)	·080
Length of premolar series	·033
Length of true molar series (about)	·047
Fore-and-aft diameter of fang of canine	·008
Distance between canine alveoli	·009
Length of diastema	·115
Length of the first molar	·015
Breadth of the first molar	·010
Depth of ramus below last molar	·0245
Depth of ramus below last premolar	·0215
Greatest thickness of ramus	·017
Length of symphysis (about)	·030

Found at Henry's Fork.

HYRACHYUS ——— ?

There are three premolars of the upper jaw which we cannot refer to any known species; but they are too imperfect to justify the formation of a new species for their reception.

What appears to be a first premolar is inserted by a single broad fang; it is too much worn to show the characteristic enamel folding, and is peculiarly broad and short. The second premolar shows the usual foldings of *Hyrachyus;* save that a distinct valley enters the tooth from the posterior edge, running forward to the transverse crest, and inclosed by the curving backwards of the internal cone. The crown is nearly square; the basal ridge is scarcely marked at all.

Measurements.

	M.
Length of first premolar	·011
Breadth of first premolar	·016
Length of second premolar	·012
Breadth of second premolar	·014

HELALETES, Marsh.

Am. Journ. Sc. and Arts, 1872, p. 218.

Additional material enables us to give further characteristics of this genus, which may be thus defined: Mammals, allied to *Lophiodon*, having a third lobe to the last lower molar, short symphysis, and with the teeth of the lower jaw forming a continuous series. Astragalus has narrow, oblique condyles. Dental formula: I. $\frac{?-?}{3-3}$, C. $\frac{1-1}{1-1}$, Pm., $\frac{4-4}{4-4}$, M. $\frac{3-3}{3-3}$.

Synopsis of Species.

A. Teeth small; a small tubercle on the outer margin, between the cusps of last upper molar.......... *H. boöps.*

B. Teeth much larger and proportionately broader; no tubercle on last upper molar.............. *H. latidens.*

HELALETES LATIDENS, *sp. nov.*

Lower Jaw.—The ramus is stout, and resembles in general form that of *Hyrachyus*, but the alveolar border is straighter than in that genus; the ascending portion forms a right angle with the horizontal portion, and the masseteric fossa is deep. The symphysis is comparatively short, and there is complete bony union between the rami, which do not diverge so much as in *Hyrachyus*. As in that genus, there are several small mental foramina beneath the premolar series. The dental series forms a nearly continuous line, the only diastema being a very short one between the first and second premolars. The *incisors* have compressed fangs, and are arranged in a slight curve. The canine is small and subcircular at base. The *premolars* also are small; they somewhat resemble those of *Hyrachyus* in shape, but are smaller, and have the posterior lobe not so well developed. The first is implanted by a single fang, the others by two. The *molars* (except the last) consist of two pyramidal lobes, which form transverse cutting-crests, as in *Tapirus* and *Hyrachyus*. The basal ridge is shown on the anterior and internal sides only. Externally the lobes meet at their bases, inclosing the valley on that side. The last molar is by far the longest of the series, and consists of three lobes, of which the anterior is the largest, and the posterior the smallest.

The basal ridge at the anterior part of the tooth is very strongly marked.

Upper Jaw.—The molars increase in size from first to last with considerable regularity. The premolars are small, and, as in *Hyrachyus*, have one single internal cone, which is joined by transverse ridges from the two outer cusps; the anterior accessory tubercle is well developed. The first molar is considerably larger than the last premolar; it is much worn, and does not show anything more than that there are two internal cones. The anterior conical buttress is very largely developed throughout the true molar series. The second and third molars resemble almost precisely the corresponding teeth of *Hyrachyus*. Their shape, however, is more nearly square than is usual in that genus.

Measurements.

UPPER JAW.

	M.
Length of true molar series	·036
Length of last molar	·0135
Width of last molar	·015
Length of second molar	·012
Breadth of second molar	·015
Length of first molar	·0105
Breadth of first molar	·012
Length of last premolar	·009
Breadth of last premolar	·011
Length of third premolar	·008
Breadth of third premolar	·009

LOWER JAW.

Length of true molar series	·042
Length of last molar	·018
Breadth of last molar	·009
Length of second molar	·013
Breadth of second molar	·008
Length of first molar	·012
Breadth of first molar	·008
Length of third premolar	·008
Breadth of third premolar	·005
Diameter of canine at base	·006
Length of symphysis (about)	·027

Found at Henry's Fork.

ARTIODACTYLA.

GENERA INCERTÆ SEDIS.

ITHYGRAMMODON, *gen. nov.*

Our fragments of this fossil show an animal about the size of the llama, and approximating more closely to the *Tylopoda* than to any living forms.

The genus is established upon the two premaxillary bones, containing the incisors, parts of the maxillaries, the canine and the first premolar; besides fragmentary portions of the palatine plates. As the peculiar features of these remains render them unique, we are warranted in establishing the genus *Ithygrammodon.*

Generic characteristics.

The premaxillaries are long, narrow, and very straight, bent slightly in on their own axis as in *Camelidæ*, but expanded laterally at the end of symphysis as in *Pecora.* The upward processes are sharply defined, with a wide, rounded upper border.

The upper incisors are six in number, and *are placed nearly in a straight line fore and aft*, separated from each other and from the canine by small and subequal diastemas.

The *incisors* are nearly equal in size, cylindrical in shape, are placed vertically in their alveoli, and are slightly recurved.

The spine of the premaxillaries is long and thin, giving very long anterior palatine foramina, as in *Ruminantia.* The premaxillaries, in position, are close together, showing a very narrow muzzle.

The maxillaries have two well-developed canines, with long, laterally compressed fangs, recurved and becoming circular in section at the crowns. The diastema between the canine and the first premolar is proportionate to that in *Procamelus*.

ITHYGRAMMODON CAMELOIDES, *sp. nov.*

Specific characteristics.

The *premaxillaries* (See Plate X., Figs. 1–4) are long, with a wide, strongly upward curving process; from the premaxillary symphysis to the third incisor, they increase in thickness; then narrow slightly to the maxillary symphysis. The upper margin of the process is smooth and narrow, curving very gradually upwards; while the lower margin runs more abruptly up, giving to it a strongly pointed curvature.

The outer surfaces are smooth and slightly convex; the inner are marked by a wide deep canal running from just behind the premaxillary symphysis into the maxilla.

The great size of this groove may perhaps be a generic characteristic; as it is much larger than in *Protolabis* (Plate X., Fig. 6), the modern camels, or any of the other ungulates, recent or fossil, that have come under our notice.

The premaxillaries do not co-ossify, as the spines are smooth on their inner side. Just outside the spines, and in front of the deep groove, the bones are marked by numerous small pits for the attachment of the muscles of the upper lip.

The portion of the maxilla in which the first premolar is situated, shows that the maxillaries swell considerably on their alveolar border; for the canine then narrow gradually for the first premolar diastema; then swell for its reception, and become very thin in the diastema between the first and second premolars.

The Teeth.—I $\frac{3}{?}$, C, $\frac{1}{?}$, Pm. $\frac{1+}{?}$, M. $\frac{?}{?}$.

The *incisors* have quite deep fangs, are cylindrical in shape, vertical in position, and have no basal ridge.

The crown of the first is worn perfectly smooth, flat across the top, unlike the wearing exhibited in any modern form that has come under our notice. The others have their crowns broken, but indicate a nearly subequal series, with the last slightly the largest.

The canines have long, recurved compressed fangs, with rather short crowns, which are circular in section. They are much larger than in *Procamelus* or *Protolabis* of Pliocene, or the modern camels. (See X., Figs. 3, 5, 6, 7.)

The first premolar is the only one of the molar series preserved; its crown is chipped considerably, but nevertheless shows that it had one fang and no basal ridge. It resembles the incisors in form, but is slightly narrower and longer.

The genus *Ithygrammodon* has been placed for the present under the *genera incertæ sedis;* but its chief features point to an unmistakable affinity with the ruminants. It is probable that *Ithygrammodon* was the representative and the ancestor, in the eocene age, of that type of ungulates of which the camel and llama are the modern forms.

The line of descent of the camels was first indicated in the Proceedings of the Philadelphia Academy, 1875, p. 262; then in the Bulletin No. 1, 1874, p. 25, of the U. S. Geological Surveys of the Territories, (Government Report of Explorations of 1873, pp. 498–500); and lastly in U. S. Geographical Surveys of Territories, vol. iv., pp. 341–44.

In the above writings, Professor Cope traces the development of the modern camels from the miocene genus *Poëbrotherium*, Leidy, showing the modifications found in *Procamelus*, Leidy, and *Protolabis*, Cope, of the succeeding age.

From the last work (Wheeler's Survey, vol. iv., p. 342), we will quote at length:

"The evolution of the existing types of Camelidæ is a good illustration of the operation of the laws of acceleration and retardation. In evidence of this we may follow the growth of the foot and dentition of the most specialized, and therefore the terminal genus of the series, the American *Auchenia* ——. It is well known since the time of Goodsir, that the embryos of ruminants exhibit a series of superior incisor teeth which disappear early. It is probable, but not certain, that in the miocene genus *Poëbrotherium*, as in various contemporary selenodont artiodactyla, the superior incisors persisted. I have, however, discovered that these teeth persisted in the Loup-Fork genus *Protolabis* during adult life. I have found that one (the second) of these teeth in *Procamelus occidentalis* persisted, without being protruded from the alveolus, until nearly adult age.

"In genera (*e.g.*, the bunodont artiodactyla) where the incisors are normally developed, they appear at about the same time with the other teeth, and continue to develop to functional completeness. This development is retarded in *Protolabis*, since they are not so matured as to remain fixed throughout life in their alveoli.

"In *Procamelus*, the retardation is still greater, since the first incisor reaches very small dimensions, and is, with its alveolus, early removed; while the second incisor only grows large enough, and for a sufficient time, to occupy a shallow alveolus, without extending beyond it. In the first incisor the process of retardation has reached its necessary termination, *i.e.*, atrophy or extinction; while in the existing *Camelidæ* the second incisor also has disappeared the same way. In ruminants other than *Camelidæ*, the third or external incisor has undergone the same process, while in the *Bovidæ* the canines also have been retarded in development, down to atrophy."

Professor Cope continuing the discussion of the teeth of these types, generalizes: "From these and many analogous cases, the general law may be deduced that *identical modifications of structure, constituting evolution of types, have supervened on distinct lines of descent?*"

This summary of Professor Cope's conclusions has been necessary to show clearly in this series the probable place of the eocene genus.

From the shape of the premaxillaries and maxillaries, and the form and position of the teeth the camelline affinities have been indicated. Future research must be relied on to throw light upon the structure of the limbs and the axial skeleton; as it is from these that the conclusive proof must be deduced that *Ithygrammodon* is the ancestor of the camels, and that *Poëbrotherium* is the second link in the chain, instead of the progenitor.

Measurements of Ithygrammodon cameloides with Protolabis.

	Ithygrammodon c.	Protolabis.
Length of alveolar border of premaxillaries.....	·035	·049
Greatest height of premaxillaries................	·017	·022
Greatest width of premaxillaries at last incisor...	·013	·0115
Thickness of premaxillary process.............	·010	·017
Length of diastema between first and second incisors................................	·0035	
Length of diastema between second and third incisors................................	·003	
Length of diastema between third incisors and canine................................	·004	
Teeth.		
Fore-and-aft diameter of first incisor.......... ..	·007	
Fore-and-aft diameter of second incisor........	·0075	
Fore-and-aft diameter of third incisor...........	·008	011
Fore-and-aft diameter of canine............. ...	·012	012
Fore-and-aft diameter of first premolar..........	·011	·011
Transverse diameter of first incisor.............	·007	
Transverse diameter of second incisor..........	·0073	
Transverse diameter of third incisor.....	·0085	
Transverse diameter of canine..................	·0113	·009
Transverse diameter of first premolar...........	·005	.007

AMBLYPODA.

(Cope. Wheeler's Survey. vol. iv., pp. 178 *et ss.*)

"Mammalia, with small cerebral hemispheres which leave the olfactory lobes and cerebellum exposed. The feet short and plantigrade, with numerous (in the known genera, five) digits, terminating in flat, hoof-bearing, ungual phalanges. The seven bones of the carpus distinct, the unciform articulating with both lunar and cuneiform. The astragalus flat, without trochlear surface, and attached to the tibia with very little freedom of movement; its distal extremity divided into two facets, one for the navicular, and the other more or less for the cuboid. Molars inserted with enamel, with wide crowns and transverse crests. A postglenoid process."

This order falls naturally into two sub-orders:

"I. A third trochanter on the femur, and a fossa for the round ligament: no alisphenoid canal; superior incisors present............................*Pantodonta.*

"II. No third trochanter, nor fossa for the round ligament; an alisphenoid canal; no superior incisors.*Dinocerata.*"

This sub-order, Dinocerata, includes at present three distinct genera, *Uintatherium*, Leidy, *Dinoceras*, Marsh, and *Loxolophodon*, Cope (also probably *Megacerops*, Leidy). These three genera, in addition to the characters above given, are marked by the possession of two or more osseous projections from the upper surface of the head; and of these the posterior pair, developed from the parietals, are the largest.

Synopsis of genera of

DINOCERATA.

A. Cervical vertebræ long; median horn-like processes anterior to the orbit; nasal tuberosities do not overhang the nasal tips.

(*a*) Last molar, with or without a tubercle, occupying the entrance of the valley between the lobes, and but one on posterior basal ridge. Temporal fossæ not continued beyond the base of the parietal processes. Occipital condyles projecting.......................... *Uintatherium.*

(*b*) Last molar never has a tubercle at entrance of valley, and has two on posterior basal ridge. Temporal fossæ continued very far back; condyles sessile....................... *Dinoceras.*

B. Cervical vertebræ short; median horn-like processes directly over the orbit; nasal tuberosities overhang the entire tips.... .... *Loxolophodon.*

Synopsis of species of

UINTATHERIUM.

A. With a tubercle occupying the entrance of the valley between the lobes of the last upper molar.. *U. robustum.*

B. No tubercle at the entrance of the valley.

(*a*) Nasals divided by a deep groove; slender zygomatic arch; dorsal vertebræ compressed. *U. Leidianum.*

(*b*) No nasal groove; stout zygomatic arch; dorsal vertebræ subcylindrical............ *U. princeps.*

UINTATHERIUM.

Leidy, Proc. Ac. Nat. Sc., 1872, p. 169.—Cont. to Ext. Vert. Faun. of Western Territories, p. 93.—Cope, Hayden's Survey, 1872, p. 580, etc.

Skull broader proportionally than in the other genera of the order, ridged and possessing several concavities on the upper surface; zygomas slender and but little curved; temporal fossæ comparatively short and have well-defined superciliary margins. The cervical vertebræ are rather long; the sacrum has four vertebræ; and the tail is quite long, very flat and broad. The tibia has its proximal face divided by a prominent ridge into two parts. The dental formula for the upper jaw is: I. o, C. 1, M. 6. The molars are small, and increase from first to sixth. The last is much the largest; in it the anterior lobe considerably exceeds the posterior in size, and there may or may not be a tubercle at the entrance of the valley between the lobes; but there is always one developed from the cingulum at the posterior part of the tooth.

UINTATHERIUM LEIDIANUM, *sp. nov.**

Established upon a head and nearly perfect skeleton of one individual, and parts of two more.

In this species, as in most others of the sub-order, the *nasals* are of immense length and thickness; they overhang the anterior nares, and project considerably beyond the premaxillaries; they form more than half of the entire length of the skull, articulating with the frontals somewhat behind the orbits; the median suture is distinct throughout. Instead of having an expanding shovel-shaped forward projection, as in *Loxolophodon*, they narrow from the median osseous projections (horn cores?) anteriorly. Above the muzzle they are strongly curved from side to side, on their upper surface forming a continuous arch; on the under surface of each bone is a deep concavity, separated from its fellow by the sutural ridge, which disappears forwards, near the extremity. On the upper surface of each nasal, near the forward end, is a large osseous tuberosity which is directed forwards and outwards; these processes are much smaller than the corresponding ones in the *Loxolophodon,* while they are larger, of different shape and direction from those in *Dinoceras.* In this species they are divided throughout by a deep median groove, which anteriorly becomes a fissure, and separates the extremities of the nasals completely. In front of these tuberosities, the nasals taper very rapidly, and

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*** This species is respectfully dedicated to Dr. Joseph Leidy, of Philadelphia. The specimens upon which it is established were found on Dry Creek plateau.**

end in sharp points which project downwards and forwards; this portion of the bones is shorter, sharper, and projects more decidedly downwards than in *Dinoceras*. Above and slightly behind the sockets of the cranium, the nasals and maxillaries give rise to the median pair of osseous projections. These are very large, subtrihedral at the base, and project upwards, outwards, and strongly forwards. They differ from the corresponding processes in *Dinoceras*, in their forward projection, in being longer and more everted, and in their approach to each other at the base. They taper quite regularly from base to tip, but do not come to a point; a section here would be subcircular. They are not so long and are not knobbed at the ends as in *Loxolophodon*. Their inner curve is convex, the outer concave; converging below at an angle of 90°, they are united by a strong ridge, which is raised decidedly above the surface of the nasals. At their posterior insertion they touch the frontals, lachrymals, and malars. It is probable that the nasals send up processes on the internal and posterior side of these median projections; the sutures between these and the maxillary portions are marked by slight ridges.

Frontals. In our specimen it is very difficult to determine the exact relations of these bones. The nasals narrow at their posterior end, and articulate with the frontals by a V-shaped suture which thus encloses them on each side. It is probable that the frontals run to some point between the posterior or parietal projections. If we have discovered the suture, they overlap the parietals, sending up V-shaped processes, which join the sides of the posterior cranial projections, and form a deep concavity with them. They constitute a large part of the interior wall of the orbit, but have no post-orbital processes; the superciliary ridge is very strong, and gradually rises into a large rounded crest, which joins the posterior projection. The frontal eminences are large, and situated immediately over the lachrymals. The upper surface of the frontals is marked by two high ridges, which probably represent the divided parts of the sagittal crest; they rise from the anterior margin of the bones, and are strongest above the frontal eminences. They converge, and then diverging, together forming an X-like curve (without crossing, however), gradually disappear posteriorly. These various ridges form four deep concavities on the upper surface of the skull: (1) The largest already mentioned, between the parietals and the posterior part of the frontals; (2) that marked by the suture between the nasals and frontal, not so large; (3 and 4) two much smaller lateral ridges between the sagittal and superciliary ridges. This great irregularity of the upper surface of the head is, so far as is yet known, peculiar to *Uintatherium*.

Parietals.—The peculiar feature of these bones is the huge pair of projections (the so-called "posterior horn cores") to which they give rise. The outer margin of these processes is nearly straight; the inner margin for its upper two thirds is also straight, the lower third curving in a high strong ridge to meet its fellow. The anterior face is rounded and produced into the long crest of the frontals, while the posterior face is flattened and produced into a similar but shorter and higher crest which joins the supra-occipital. At the base of these processes their greatest diameter is fore and aft, while at the top it is transverse. They project upwards and outwards, but are not curved as in *Dinoceras*, nor are their upper borders so much arched. Their greatest diameter at top is at right angles to the corresponding measurement in this last-named genus. Behind the ridge which connects these projections, the parietals curve sharply upward to a high occipital crest; between which and the projections they form a deep basin whose floor is raised above that formed by the frontals immediately anterior to it. This arrangement differs from that of both *Loxolophodon* and *Dinoceras*, especially from the latter. The temporal fossæ are of great length, deeply concave, but rather low from above downwards, formed almost entirely by the parietals, and bounded posteriorly by a sharp outward curve of these bones. They are of about the same proportionate length, but higher and very much deeper than in *Loxolophodon*; and are not nearly so long as in *Dinoceras*, in which genus the parietals expand far behind the horn-like processes. In our specimen the posterior part of the fossa is pierced by numerous small venous foramina, and corresponds precisely in every way, save that of size, to the specimen figured by Dr. Leidy. (Cont. to Extinct Vert. Fauna, Plate XXVI., Fig. 1.)

The Squamosals are large and heavy, but encroach little upon the temporal fossæ; they are situated directly below the large parietal projections. The glenoid cavity is transverse and straight in this direction, broad and shallow, with no internal process; and the post-glenoid process is long and massive. The zygomatic process is short, stout, high, and trihedral, with a strongly arched upper margin. The articulation with the malar is by a straight, flat face, and anchylosis of the two never takes place. The anterior termination is pointed, and the outer margin is rounded.

The Malars form none of the face. They are long, slender, curved downwards and backwards, and but little outwards. They are longer,' straighter, and less curved outwards than in either *Loxolophodon* or *Dinoceras;* they do not present the sharp angle in the lower margin shown in the latter genus, nor are they so extensively overlapped by the zygomatic processes of the squamosal. Posterior to the molar series, the malars are greatly compressed and very slender, but at the junction with the maxillaries they become much wider and thicker. There is no trace of a postorbital process; and the projections from the under surface of the bone at their junction with the squamosals, so prominent in *Dinoceras*, are here rudimentary or absent. As a whole, the zygomatic arch is very long, slender, simple, curved upwards and very slightly outwards, so slightly that it is completely overhung by the superciliary ridge and frontal crest.

The Lachrymals are unusually large, and form the anterior part of the orbit; they encroach considerably upon the face, and articulate with the superciliary ridges above. The lachrymal foramen is very large.

The Maxillaries are of great length, being nearly as long as then asals. They extend somewhat beyond the last molar; but the suture between them and the pterygoids is very obscure. There is a very long diastema between the canine and molar series, and the lower margin is arched upwards; above this, between the orbit and the socket of the canine, there is a large, deep fossa, but we can discover no infra-orbital foramina. The sockets of the canines are very large and prominent, they curve upwards and backwards to the base of the median cranial projections, but these are not excavated to receive them, as is the case in *Dinoceras*. The most peculiar feature of the maxillary bones is the pair of large horn-like projections, to which, in conjunction with the nasals, they give rise. These have already been described, and it only remains to add that they correspond in position to those of *Dinoceras*, and are therefore much further forward than those of *Loxolophodon*.

The palatine plates of the maxillaries are long and very narrow; they are concave transversely, and are separated from each other by a high median ridge. The posterior palatine foramina are small.

The *Palatines* are very short, narrow, and concave, and are separated by a ridge. They are considerably excavated on the posterior border, in this respect differing from *Loxolophodon*.

The *Pterygoids* and the pterygoid plates of the alisphenoid are compressed; the former join the alveolar borders of the maxillary, which are produced somewhat beyond the last molars. The alisphenoid canal is very large, but rather short.

The *Premaxillaries* are of very peculiar shape, somewhat like a *u*, with one side—the lower—the longer. The upper portion articulates with the nasals, running along the narial opening to about three inches from the angle; the free portion is short, slender, and tapering; it is curved downwards and slightly inwards; the premaxillaries do not meet, leaving the incisive foramen unenclosed, and are edentulous. At the end of the upper portion there are prominent processes for the attachment of the muscles of the proboscis, which probably resembled that of the tapir.

The anterior narial opening is very large, but is considerably concealed by the overhanging of the nasals. There is no osseous septum between the nostrils. The posterior nares are much smaller, being especially contracted in width; it is divided above by the *Vomer*, which is very short, and does not reach the palatines. The nasal cavity thus formed is long, straight, and gradually narrows backwards.

Of the *Mandible* we have but a small portion of the right ramus, comprising the part opposed to the upper canine, from the dental canal downwards. The jaw at this place has a large downward-projecting process, very similar to that figured by Marsh in his plate of *Dinoceras laticeps.* This process curves slightly outward, and has its external side convex in both directions, and its internal side convex fore and aft, concave from above downwards. The posterior mental foramen, which is the only one preserved in our specimen, corresponds in size and position with *Dinoceras laticeps.* The only difference between the two is a very slight one: in *D.* the curve of the posterior margin of the process is convex; in *Uintatherium* it is concave; the angle which the process makes with the jaw is also greater.

Cranial Measurements.

	M.
Length of bony palate	·227
Length of head along the top	·743
Length of nasals	·398
Breadth at nasal tuberosities	·123
Distance between median projections	·385
Breadth of head posterior to median projections	·189
Breadth of head before posterior projections	·228
Breadth of head behind posterior projections	·312
Distance between extremities of posterior projections	·462
Length of nasals to ridge between median projections	234
Length from ridge between median to ridge between posterior projections	·374
Length of zygomatic arch (straight)	·285
Length from angle of nares to end of nasals	·162
Length from angle of nares to end of premaxillaries	·114
Width between tips of premaxillaries	·053
Circumference of median projection at top	·203
Circumference of posterior projection at top	·329
Height of median projections from ridge between them	·174
Height of posterior projections from ridge between them	·239
Length of nasals anterior to nasal tuberosities	·0415

Teeth.—These are peculiar for their small size compared with the bulk of the animal; for their slender fangs, and for the distance through which these are exposed.

Upper Jaw.—Formula: I. $\frac{0}{0}$, C. $\frac{1}{1}$, Pm. $\frac{3}{3}$, M. $\frac{3}{3}$.

Canines.—The sockets of these teeth have been already described: the fangs are very long, somewhat longer than the crown, and the teeth apparently grew from permanent pulps.

The crown is long, compressed and recurved; the posterior margin is sharp, and exhibits some indications of a slight serration.

Premolars.—The first premolar is not preserved in our specimen. The second and third are subequal, and of about the same conformation. They are implanted by three fangs, one internal and two external. The crown is subcircular at the base. The basal ridge is large, and completely surrounds the crown; above this the crown becomes somewhat trihedral: and is composed of two pyramidal lobes, which meet internally and externally, and are divided by a valley. The summits of the lobes form transverse grinding ridges; the anterior one is the lower, and is crescent-shaped, while the posterior is straight; the anterior ridges throughout the series are much the most worn. The basal ridge is not indented on the outer side at the opening of the valley as in *Dinoceras*.

Molars.—The true molars increase in size regularly backwards. The first molar is larger than the last premolar; it is worn down nearly to the basal ridge, but shows a small internal accessory tubercle on the back part of the posterior lobe. The extremities of the lobes rise into points, and their summits are transversely concave. The number and arrangement of the fangs in the first and second molars is the same as that of the premolars; in the last molar there are but two, which are long and wide, and extend the whole breadth of the crown. This tooth is by far the largest of the molar series; it is ovoidal in shape, with the apex at the outer point of the forward lobe; it is proportionally broader than in *Uintatherium robustum*. The basal ridge is strong, and extends around the entire tooth, with some irregularities of outline at the sides. This tooth, like the others, consists of two pyramidal lobes separated by a valley, which in this case is wide and deep. The summit of the anterior lobe is the longer, and extends obliquely across the crown, while the posterior is nearly straight. The free ends and junction of the lobes are prolonged into points, which give a tripodal character to the crown. The outer point of the anterior lobe is the longest of the three, but the difference is not nearly so marked as in *U. robustum;* the other two are of about the same height;

but the external is spinous in character, while the internal is stout and obtuse. The anterior slope of each lobe is steep, while the posterior is long and gentle. As in *U. robustum*, there is a small rounded tubercle on the inner side of the posterior basal ridge; but there is no tubercle occupying the entrance of the triangular valley between the lobes. The enamel of all the molars is smooth.

Teeth Measurements.

	M.
Length of molar series	·148
Length of premolar series	·062
Length of true molar series	·089
Fore-and-aft diameter of second premolar	·022
Transverse diameter of second premolar	·023
Fore-and-aft diameter of third premolar	·022
Transverse diameter of third premolar	·023
Fore-and-aft diameter of first molar	·023
Transverse diameter of first molar	·026
Fore-and-aft diameter of second molar	·028
Transverse diameter of second molar	·031
Fore-and-aft diameter of third molar	·039
Transverse diameter of third molar	·044
Distance between last molars	·058
Distance between first premolars	·049
Distance between first molars	·074
Fore-and-aft diameter of root of canine	·060
Transverse diameter of root of canine	·039
Length of diastema	·072
Distance between canine alveoli	·080

Lower Jaw.—Dr. Leidy has very kindly sent us some of the lower molars of an undescribed *Uintatherium*, which may belong to this species. They consist of the anterior lobe of the last molar, and second and third premolars entire. They all have nearly the same conformation, consisting of three acute pyramidal lobes, of which the anterior is very much the highest and broadest; the median lobe is partly separated from the anterior by a valley which opens outwards, while the valley between the posterior and median lobes passes completely across the tooth. The highest point of the crown is the inner end of the anterior lobe; but the difference between this and the outer end, very great in the molars, becomes slight in the premolars. The inner end has an accessory tubercle just at the lip of the anterior lobe, and there is another on the anterior basal ridge. This latter feature would seem to distinguish it from *U. robustum.*

The basal ridge is distinct in front and behind, indistinct on the external side, and entirely absent from the internal.

Measurements.

(TEETH, LOWER JAW.)

	M.
Transverse diameter of last molar	·026
Height of highest point above cingulum of last molar	·023
Fore-and-aft diameter of second molar	·0285
Transverse diameter of second molar	·023
Height of second molar	·0215
Length of fourth premolar	·021
Width of fourth premolar	·015
Height of fourth premolar	·020
Length of third premolar	·020
Width of third premolar	·015
Height of third premolar	·014

Vertebræ.

Cervical region (Plate VI., Fig. 1).—(Only one preserved, probably fifth or sixth.)

The centrum is short, compared with the dorsals, but is much longer than the cervical centra of the *Proboscidea;* it is broad and depressed, oval in form, and slightly opisthocœlous. The zygapophyses are developed upon tuberous projections of the pedicles; they are large, flat, and in the same plane with each other. The diapophyses are very slender and short, and but slightly heavier than the parapophyses, with which they unite, enclosing a large vertebraterial canal. At the anterior margin of the parapophysis, a small pointed process projects downward.

The pedicles are low and very heavy, bounding a narrow neural canal.

The epiphyses are not so completely ossified as they are in the dorsal region.

Dorso-lumbar region (Plate VI., Figs. 2, 3, 4, 5).—(Description based upon nine dorsals and two lumbar vertebræ.)

The centra are large, subtriangular, and slightly compressed; they are opisthocœlous, but less so than in the *Proboscidea.* They increase in size slowly but regularly from before backwards. In the middle dorsal region they are excessively expanded laterally for the posterior-costal attachments; but become less broad and higher as they recede in the series. In the middle of the series the centra are marked by a prominent hypophysial keel.

In the anterior dorsals the costal surfaces are developed almost entirely upon the pedicles, and are two in number. These are very large in about the sixth and seventh, and meet. They decrease in size as they recede. In the middle region the posterior costal surfaces are small, lozenge-shaped facets, and are developed upon thin lateral projections of the centra.

The centrum of the last dorsal is heavy, resembling the centra of the lumbar, from which it is distinguished by a single pair of small costal surfaces, developed, half on the pedicles and half on the centrum.

The neural spines are markedly smaller than those of the *Proboscidea* and *Rhinoceros;* in the anterior part of the dorsal region the spines have the same angle as the corresponding ones in *Mastodon.* The spines of the twelfth and thirteenth (approximately) are much expanded at the ends and bifid; in the last dorsals they are wide, straight, and very thin; in the lumbar region they are short, stout, tuberous, and stand almost at right angles to the axis of the vertebræ. The laminæ in the anterior part of the series are long and thin, decreasing in length but increasing in thickness from before backwards. The zygapophyses in the fore part of the dorsals are mere flat facets on the laminæ; they increase in size and become characteristic in the posterior part of the dorsal region. The pre-zygapophyses of the last lumbar vertebra are very large, deeply concave, and parallel with the axis of the column. The metapophyses appear in the middle of the series, and regularly increase in size to the last lumbar. From their appearance the pre-zygapophyses are developed upon them.

The transverse processes present the most unique feature of the vertebral column. In the anterior region they are long, wide, and rugose, and in the same plane with the laminæ; they send directly out wide, downward-curving projections.

In the middle dorsal region the transverse processes lose these thin projections, and become heavy and subtrihedral, with a smooth facet on their lower face for articulation with the tubercle of the rib; their upper face is here a little twisted from the plane of the laminæ. In the posterior dorsal region the transverse processes lose the facet for the articulation with the tubercle of the rib, and become short and very thin, pointing slightly backwards.

The lumbar transverse differ from those of the last dorsal in having a median transverse ridge on their posterior face, and are directed more vertically out.

The pedicles throughout most of the dorsal series are short, heavy, and deeply notched behind. In the posterior dorsal region they become longer and more slender, resembling almost exactly the pedicles of the lumbar region.

Sacral region.—The sacrum is composed of four vertebræ, three true and one pseudo-sacral. The centra are extremely depressed, and rapidly decrease in width and thickness from before backwards. The first is shorter than the last lumbar, but much longer than the other sacrals, which are subequal.

The face of the first is elliptical, and is nearly three times the diameter of the fourth, longitudinally. The metapophyses are exceedingly large and tuberous on the first; with wide, deeply concave pre-zygapophyses developed upon them; in the other three the metapophyses are rudimentary.

The transverse processes are long and wide in the first three; widest in the first but thickest in the second; long and thin in the fourth. The pleuropophysial segments of the true sacrals are very heavy.

The foramina enclosed by the transverse processes are large; and have, on the internal side, their long diameter obliquely transverse to the axis of the sacrum.

The inferior faces of the centra are slightly concave in the first three. The first and fourth have slight hypophysial keels.

The neural canal is very wide and depressed in the first, but decreases rapidly backwards, becoming extremely small in the last.

Caudal region (Plate VI., Fig. 6).—(Description based upon the first four.)

The centra of the caudal vertebræ are rather long, narrow, and greatly depressed in the middle; they decrease in size gradually backward. The pedicles and laminæ are short and thin, enclosing a small neural canal. The neural spines point directly back, being almost parallel with the axis of the centrum. They are slender and tuberous at the extremity. The transverse processes are very long, wide, and thin, thickened somewhat at the ends, and project directly out; they decrease in size backwards. From the persistence of the neural canal, and from its comparative size, it would seem as if the tail was considerably larger than that of the elephant.

Measurements of Vertebræ.

Cervical region (Plate VI., Fig. 11).

	M.
Diameter of cervical (vertical)	·079
Diameter of cervical (transverse)	·111
Diameter of cervical (fore and aft)	·051
Extreme length of prolongation of pedicles for zygapophyses	·089
Long diameter of vertebraterial canal	·040
Width of pedicles	·035

Dorsal region (Plate VI., Figs. 2 and 3).

	M.
In anterior region: Diameter of centrum (fore and aft)	·075
Diameter of centrum (vertical)	·062
Diameter of centrum (transverse)	·142
In posterior region (Plate VI., Fig. 3). : Diameter of last dorsal (vertical)	·087
Diameter of last dorsal (transverse)	·110
Average width throughout the series of neural canal	·097
Width of transverse process (anterior dorsal) (Fig. 2, Plate VI.)	·075
Length of lamina from prezygs. to post-prezygs. (Fig. 2, Plate VI.)	·12
Length of transverse process (middle dorsal), (Fig. 3, Plate VI.)	·055
Vertical length of anterior dorsal from tip of spine to hypapophysial keel	·183
Width between inner margins of metapophyses (last dorsal)	·172

Lumbar region—Last lumbar (Plate VI., Figs. 4 and 5).

	M.
Diameter of centrum (fore and aft)	·095
Diameter of posterior face (transverse)	·111
Diameter of posterior face (vertical)	·078
Extreme width between transverse processes	·214
Width between pre-zygapophyses	·110
Length of neural spine from lamina	·060
Vertical length from tip of spine to lower side of centrum	·194

Sacral region.

	M.
Length of sacral series	·264
Transverse extent of sacral series	·298
Diameter of first vertebra at free end (transverse)	·109
Diameter of first vertebra at free end (vertical)	·072
Diameter of first vertebra at free end (fore and aft)	·070
Diameter of last vertebra at free end (transverse)	·053
Diameter of last vertebra at free end (vertical)	·031
Diameter of neural canal at first vertebra (transverse)	·100
Diameter of neural canal at last vertebra (vertical)	·018
Long diameter of first transverse foramen (internal side)	·076

Caudal region (Fig. 6, Plate VI.).

	M.
Length of first four	·252
Diameter of centrum, first (fore and aft)	·061
Diameter of neural canal of first (transverse)	·035
Extent of transverse process in first	·085
Extent of transverse process in fourth	·046
Fore-and-aft width of transverse process of first in the middle	·048

Ribs.—Description based upon two perfect ones, and parts of four more.

The ribs, as in *Dinoceras*, "resemble very much those of the *Mastodon*." The capitulum has two convex facets, separated by a narrow groove. The sternal-end in one is very much expanded, but less so in the other. The tubercle is small, and is situated upon the prolongation of the lamelliform process for the intercostal muscles. The angle is much sharper than in the corresponding ribs of *Mastodon*.

Measurements of Ribs.

	M.
Length of rib without curvature	·571
Length of rib with curvature	·739
Width of rib just below head	·049
Width at muscular attachment	·063
Vertical diameter of larger facet of capitulum	·039

Scapula (Plate VIII., Fig. 1).—The scapula is sub-triangular, with the pre-scapular border as base, and the apex half way up the post-scapular.

On the external side the pre-scapular fossa is concave antero-posteriorly, and plane in the direction of its length; it is very thin in the middle, but becomes heavier at the lateral border. The postscapular fossa is larger and less concave; both fossæ, as they approach the upper border, gain greatly in thickness.

The spine rises from the supra-scapular border, and extends to within an inch from the glenoid cavity. It is decidedly antroverted; thickest and highest near glenoid cavity; thinnest and lowest in the middle, expanding again at its upper extremity; its acromio-scapular notch is long and shallow. The acromion is rudimentary.

The coracoid process is a low, rugose tuberosity; the coraco-scapular notch is short and low.

The internal surface of the scapula has a large, smooth median ridge, extending the whole length of the bone, separating it into slightly concave fossæ. About two thirds up, the median ridge sends obliquely up two branches, forming a V, superimposed upon the main ridge; but these disappear before they reach the upper extremity. The whole inner surface is curved outward, presenting a concave appearance throughout.

The glenoid cavity is deep, ovoid in form, with its greatest diameter fore and aft, and its smaller end behind.

The resemblance between the scapula of *Uintatherium* and that of the *Proboscidea* is more closely marked than in any other corresponding bones. The chief points of similarity are: first, the subtriangular shape; second, the same relative proportions between the fossæ; third, the antroversion of the spine; fourth, the glenoid cavity looking directly down. The marked points of difference may be summed up as, first, in the dissimilar proportion of the glenoid cavity; second, the great thickening of the spine at its upper and lower extremities; third, in the high, shallow acromio-scapular notch; fourth, in the longitudinal concavity of the internal surface.

Measurements.

	M.
Extreme length of scapula	·42
Extreme length of spine	·31
Extreme thickness of spine at upper margin	·098
Extreme height of spine	·109
Basal width of proximal end of spine	·032

Basal width of distal end of spine	·030
Basal width of middle part of spine	·011
Length of glenoid cavity	·149
Width of glenoid cavity	·096

The Humerus (Plate VII., Fig. 1).—The humerus is short, but excessively stout, twisted slightly on its axis; it decreases gradually in size downward, with the smallest diameter about two inches below the end of the deltoid ridge. The head is large, hemispherical, and sessile, projecting very slightly out of the axis of its shaft. The great tuberosity is heavy, but not high, and is separated from the low lesser tuberosity by a shallow bicipital groove.

The trochleæ are very nearly equal in size, directed obliquely to the axis of the shaft, and are separated by a narrow groove, which runs from the supra-trochlear fossa down and in, then back and up to the anconeal fossa. The condylar tuberosities are large and rugose; the external is the greater, and is directed antero-posteriorly. The deltoid ridge is long and heavy, and extends nearly two thirds down the shaft, branching out into two forks near its end. The supinator ridge is short and rudimentary, differing in this respect entirely from the great development found on the humerus of the *Proboscidea.*

The supra-condylar fossa is small, sub-circular in form, and very deep, it has the peculiarity of being placed above the external condyle alone. The anconeal fossa is median in position and quite deep.

Measurements of Humerus.

	M.
Length	·63
Smallest circumference of shaft just below deltoid ridge	·288
Greatest proximal circumference below greater tuberosities	·45
Width of trochlea on anterior side	·154
Length of anconeal fossa	·071
Width of anconeal fossa	·062
Width of distal end at condylar tuberosities	·23
Length of deltoid ridge	·22
Length of groove running from supra-trochlear to anconeal fossa	·272

The Ulna (Plate VII., Fig. 2).—The ulna is long, heavy at both ends, with a slender trihedral shaft that curves forward, and decreases in size as it approaches the distal end.

The proximal end has its articular face for the humerus divided into three facets, the vertical being long and extremely convex; the horizontal has the pre-axial face the longer. The olecranon is very massive and rugose, sending up on its external side a high, pointed projection; while on the internal side, the olecranon becomes compressed and projects inward; these tuberosities are separated by a wide, shallow groove for the tendon. The distal articular face is large, single, and is concave antero-posteriorly, and convex laterally. The styloid process is very heavy.

Measurements of Ulna.

	M.
Length of sigmoid notch	·089
Width of sigmoid notch (horizontal face)	·049
Diameter of proximal end below articular face (fore and aft)	·076
Diameter of proximal end below articular face (transverse)	·059
Diameter of distal articular face (fore and aft)	·061
Diameter of distal articular face (transverse)	·051
Length of olecranon	·112

Pelvis.—The *ilia* are greatly expanded laterally, with the iliac surface concave and the gluteal surface nearly flat; thin in the middle, they increase in thickness near the borders. The crests curve regularly, and project above and beyond the sacrum, but do not bend over the acetabula. The acetabular borders are only slightly concave; the prominence for the attachment of the rectus muscle (extensor) is low and V-shaped. The direct internal surfaces of the ilia, comprised between the pubic and ischiatic borders, become deeply concave below the ischiatic portion of the acetabulum. The sacral surfaces are wide and triangular in shape; above they project beyond the sacral spines.

The ilio-lumbar angle is about 110°. The ischium is short; a section of it, as it leaves the acetabulum, is subtriangular; but immediately it becomes flattened fore and aft throughout its plane of 90° to the axis of ilium; then verging toward the pubic symphysis it becomes small. The tuberosity of the ischium is small and directed up.

The pubis, as it leaves the acetabulum, is sub-cylindrical, after this it is flattened in the same plane with the ischium

The bone as a whole is short, thin, and slightly curved on its own axis; its smallest part makes up the pubic symphysis, which is short. The thyroid foramen is a large oval, with its long diameter parallel to the axis of the ischium.

The acetabulum is large, sub-circular, and deep, with prominent borders; especially the iliac, which is produced on its external extremity into a point; the ischiatic is deeply notched. From the wide ligamentous pit in the centre there runs a deep groove part way down the antero-external side of the ischium.

The anterior opening of the pelvis is a wide oval, with its longest diameter transverse.

Measurements of Pelvis.

	M.
Transverse diameter of pelvis, including sacrum	1·171
Long diameter of ilium (from lower margin of the crest to sacral surface).	·440
Short diameter of ilium (from acetabulum to upper margin of crest)	·393
Length of acetabular border	·125
Length of ischium	·220
Width of ischium at tuberosity	·124
Length of pubis	·196
Greatest width of pubis	·061
Smallest width of pubis	·027
Long diameter of acetabulum	·139
Short diameter of acetabulum	·118
Long diameter of thyroid foramen	·094

The Femur (Plate VIII., Fig. 4).—The femur is short, with a small oval head, strongly compressed fore and aft. It is less out of the axis of shaft than in *Proboscidea*, and has no pit for the ligamentum teres. The shaft is straight and simple, much compressed transversely at the proximal extremity, becoming sub-cylindrical below.

The great trochanter is heavy, rugose, and strongly recurved; it is separated from the shaft by a wide and deep digital fossa. The second trochanter is a mere rudimental tuberosity. The condyles are nearly of an equal size, very convex, and are divided by a deep popliteal groove.

The condylar tuberosities are low, the internal sends obliquely a ridge three inches long, up and across the axis of the shaft at an angle of 45°, that forms the upper boundary of the popliteal space.

The front part of the trochlear faces for the patella are gone in our specimen.

Measurements of Femur.

	M.
Greatest distal diameter across condyles	·178
Length of condyles	·079
Transverse diameter of shaft six inches above distal end	·121

The Tibia (Plate VIII., Fig. 2).—The tibia is short, straight, and simple, slender in the middle, but much expanded at the extremities. The proximal end is especially massive, with deeply concave articular faces; the internal cotylus is the larger, and has its greatest diameter fore and aft, directly at right angles to the greatest diameter of the external.

The cotyli are separated by a smooth ridge, that is highest at its posterior termination. The tuberosity is high and massive, with a wide depression on its top for the reception of the ligament of the patella; the sides are deeply pitted by venous foramina. A section of the shaft at the lower part of the tuberosity would be subtriangular; while below it becomes more cylindrical, as it becomes smaller, reaching its shortest diameter about three fifths down the shaft. Below this it expands and forms the large subcircular distal end. The articular face is concave, with a slight, smooth ridge running fore and aft on its internal side. The malleolus is broad and low.

The *fibula* is distinct, but very slender; its proximal end has a small circular face, which articulates with the tibia on a facet developed on the bottom of a projection of the tuberosity; the distal end is much flattened, but enters into the ankle-joint.

Measvrements of the Tibia.

	M.
Transverse diameter of proximal articulation	·158
Longitudinal diameter of proximal articulation	·123
Smallest circumference of shaft	·16
Greatest distal circumference above the articular face	·308
Diameter of distal articulation longitudinally	·082
Diameter of distal articulation transversely	·130
Width of tuberosity below pit for ligament of the patella	·075

UINTATHERIUM PRINCEPS, *sp. nov.*

Established on several portions of the head, vertebral column, and the limbs.

This species may readily be distinguished from the last by its larger size, the broad nasals with small tuberosities, the stronger zygomatic arches, and the sub-cylindrical centra of the dorsal vertebræ.

The *nasals* are broad and flat for some distance behind the tuberosities. Although the animal was not adult, the nasal suture is almost obliterated, and is visible only on the inferior surface; in this respect it is very different from the *U. leidianum*, in which the suture persists throughout life; as is shown by the type specimen, which was past maturity. The tuberosities of *U. princeps* are lower, broader, and more everted than in the preceding species; are not divided by a groove, but united together by a low rounded ridge, to which the surface of the nasals gradually rises from behind. The portion of the bones anterior is short, stout, and projects horizontally.

The *median*, or *maxillary*, *projections* are apparently short and everted; they are somewhat compressed antero-posteriorly, and enlarge rapidly downwards. They are transversely oval in section.

The *posterior*, or *parietal*, *projections* are different from any that we have yet seen. They are sub-trihedral at base and flattened antero-posteriorly above. The upper margin is regularly arched, and is the thinnest portion of the process. The posterior face is perfectly flat, and the parietal crest makes a sharp angle with it, rising lower down than in *U. leidianum*; the frontal crest is also lower down than in that species, and the anterior face is strongly convex. The internal margin is rounded and straight, and does not show the longitudinal groove marked in the last species.

The *frontal* has the eminences and depressions common to the members of the genus; but the superciliary ridge is unusually sharp and sinuous in outline.

The *squamosal* is short, stout, and high; is but slightly curved outwards, but apparently projects somewhat downwards. The malar articulation is broad and flat, indicating the heaviness of that bone. As a whole the zygomatic arch is stronger, and probably shorter, than in *U. leidianum.*

The occipital condyles are proportionately rather small; they are placed on a long neck and project downwards. They are strongly convex from above downwards, but scarcely at all so from side to side. The internal border is slightly emarginate.

The *dorsal vertebræ* are of about the same proportionate length as in *U. leidianum*, but are higher and wider; and the centra are sub-circular in section, slightly contracted in the middle. The costal surfaces are wide and deep, and vertically oval in shape; they are placed partly on the centra and partly on the neurapophyses. The transverse processes are short, stout, and tuberous, and raised high above the centrum. There is a deep notch at the posterior edge of this process, at its junction with the neurapophysis. The neurapophyses are trihedral, somewhat low, and very stout, forming a wide neural canal.

The *ulna* (Plate VII. Fig. 2) is thick, with a long and rugose olecranon. The shaft is long and stout; it shows a distinct medullary cavity. The distal end is small, and shows a low, heavy, styloid process.

A *metacarpal* resembles the corresponding bone in *Dinoceras*, but is rounder and less rugose. There are two faces for carpal articulations, which meet at an open angle.

Measurements.

	M.
Breadth over nasal tuberosities	·132
Length of nasal tip (anterior to tuberosities)	·033
Circumference of maxillary projection near the tip	·208
Vertical diameter of squamosal	·058
Transverse diameter of ditto at malar articulation	·045
Length of centrum of dorsal vertebræ	·070
Height of ditto	·083
Breadth of ditto below costal surfaces	·097
Breadth of pedicle	·058
Length of transverse process	·056
Extreme breadth of transverse process	·061

Found at Henry's Fork.

UINTATHERIUM ROBUSTUM. Leidy.

Cont. to Ext. Vert. Faun., p. 96.

A fragmentary skeleton from Henry's Fork.

RODENTIA.

PARAMYS, Leidy.

"Extinct Vertebrate Fauna of the Western Territories," vol. i. Hayden's Surveys, p. 109 *et seq*.

THIS genus of the gnawers is very closely allied to the squirrels and marmots. Dr. Leidy sums up the generic characteristics of the teeth thus:

"The four lower molars are proportionately narrower than in squirrels and marmots, the fore and aft exceeding the transverse. The crowns are short, square, tuberculate, and enamelled.

"The lower jaw is proportionately shorter and deeper than in most known rodents; the reduction in length being mainly due to a less development of that part of the bone in advance of the molars. To compensate for the difference in length, and to make room to accommodate the incisors, these teeth reach further back than usual.

"The acute edge of the hiatus between the molars and incisors is almost on a level with the alveoli, of the teeth, instead of forming a deep concave notch, so conspicuous a feature in the jaws of the gnawers generally."

Species known.—

Loc. cit. { PARAMYS DELICATUS, Leidy.
PARAMYS DELICATIOR, Leidy.
PARAMYS DELICATISSIMUS, Leidy. }

PARAMYS ROBUSTUS, Marsh.

Am. Journ. Sc. v. iv., p. 218.

PARAMYS SUPERBUS, *sp. nov.*

Established on a single lower incisor.

The species indicated by this specimen is the largest of the genus as yet known. The tooth is subtrihedral in section, is stout, and shows but little curvature. The anterior and lateral faces are broad, and the under margin to which the sides converge, is narrow. The enamel is thick and is inflected so as to cover a small portion of the sides as well as the front.

Measurements.

Transverse diameter of crown	·0062
Fore and aft diameter of crown	·007

Found at Cottonwood Creek.

AVES.

THE expedition collected parts of four species of birds; a feather from Florissant Col. the distal ends of a humerus, and a femur and a portion of the shaft of an ulna (?) from the Bridger beds, but they are all too uncharacteristic for classification or description.

REPTILIA.

CROCODILIA.

CROCODILUS.

CROCODILUS APTUS, Leidy.

Contributions to Extinct vertebrate fauna of the Western Territories, p. 126.

Henry's Fork.

CROCODILUS GRINELLI, Marsh.

American Journal of Science and Arts, vol. i., p. 465.

From Cottonwood Creek.

CROCODILUS ELLIOTII, Leidy.

Cont. to Ex. Vert. Fauna, p. 126.

Represented by a perfect skull, and several vertebræ.

This fossil exhibits a form of skull which shows characters of both crocodile and alligator; the latter to a less marked degree. That it properly belongs to the former genus is shown by the notch in the upper jaw which receives the canine of the lower.

The entire skull is remarkably flat on its upper surface, the face and cranium being nearly in the same plane without the descent at the frontals usual in these reptiles. The jaw is deeply notched at the sutures between the maxillaries and pre-maxillaries, and the second maxillary notch is well marked. All the bones of the upper surface of the head are deeply pitted.

The borders of the cranium are rounded as they approach the orbits; the superior temporal orifices are almost perfectly circular, the fore-and-aft diameter exceeding the transverse by only one millimetre. This effect may, in some degree, be due to distortion.

To give a more detailed account of the several elements of the skull, we take up first the *basioccipital.* This bone is remarkably long and straight, tapers gradually downwards, and becomes quite narrow at the distal end. It is smooth throughout, and exhibits no rugose muscular attachments, such as are sometimes seen in other members of the order. The condyle is large and nearly spherical, but with median groove distinctly marked. In size and shape it is more like that of the alligator than of the ordinary crocodile, but it is somewhat different from either. It differs from the former, in not having so long a neck distinctly marked by a constriction; and from the latter, in not having additional articular faces on each side of the condyle proper. As far as can be judged, no portion of it is formed by the exoccipitals. Below the condyle, the basioccipital is perforated by two small vascular foramina; the spheno occipital canal occupies the usual place, and is very large.

The *exoccipitals* are large, of very great width, but rather low from above downwards. The position of the foramina which perforate these bones is peculiar; it resembles more the arrangement seen in the skull of the alligator than in that of the crocodile, but it has an additional foramen. There are, then, two small venous foramina near the condyle; while along the lateral margin of the occiput, are placed in a vertical line the foramina for the hypoglossal and pneumogastric nerves, and the internal carotid artery. The foramen for the facial nerve, etc., is situated in the usual place, and is of the usual size. The foramen magnum is heart-shaped, low, wide above, contracting below. The paroccipital processes are long and slender, and project strongly backwards.

The *supraoccipital* is very small. It shows to some extent on the upper surface of the skull, wedged in between the parietals. As a whole, the occiput is of remarkable shape: it is perfectly vertical, as in all other crocodilians; is remarkably high from above downwards, and is very broad at top, becoming extremely narrow distally. This latter feature is owing to the peculiar shape of the pterygoids; which, when viewed from behind, do not appear to reach the basioccipital.

The *basisphenoid* is so destroyed by crushing, that nothing can be said of its shape or of its foramina. It was, however, evidently very stout. The alisphenoid is large and smooth and is not ridged; the *foramen ovale* is small, and is not produced into an anterior notch. The suture between the alisphenoid and the pro-otic are quite distinct, but the latter is so firmly anchylosed to the quadrate that its limits are indeterminable. None of the other periotic bones are visible.

The *quadrate* is very long and broad. In shape it resembles the corresponding bone of the alligator, but is somewhat broader. The lower surface is divided into two unequal parts by a conspicuous ridge, which runs to within an inch of the articular surface. This surface has a more decidedly grooved or trochlear appearance than in the common crocodile; but not to the same degree as in the specimen described by Dr. Leidy. It is more like the Mississippi alligator in this respect than any living species of which we have specimens.

The *pterygoids* are of peculiar shape; they are long, slender, and pointed, and meeting the basioccipital on the median line in front, they project downwards and backwards. Their posterior border is very deeply emarginate, so that they seem to have no connection with each other, or with the basioccipital; instead of having the broad, plate-like appearance of these bones in recent species. The suture between these on the palatal surface is long; and the processes of the pterygoids, which bound the posterior nares, are long and stout. The posterior nares have the position which they take in the recent species; they are visible in the occipital surface, and are directed backwards as well as downwards. They are rather small, and appear to have no septum between them, but this cannot be said with any certainty.

The *transpalatine* is also somewhat peculiar in shape; the process which joins the pterygoid is of great length, being nearly as long as that bone. The other limbs are more normal in length. The three processes are connected at the usual angle.

The *palatals* are long and narrow, becoming wider anterior to the foramina. The suture with the maxillaries is rounded, and there are no forward processes as in the true crocodiles; but at the same time, these bones are not of the shape exhibited in the alligators. The palatal foramina are of immense length; they are more than one third as long as the entire bony palate. Their width is also considerable.

The *maxillaries* are long and very broad; the alveolar border is of about the same shape as in the crocodile, but less decidedly sinuous; and the posterior part passes in below the alveolus of the lower jaw. The convexity of the upper surface of the maxillaries is not so well marked as in the true crocodiles. It is nearly as flat as in the alligator. The palatine plates of the maxillaries are short, broad, and nearly flat, arching slightly to form the alveolus, and perforated along this border by rows of foramina.

The *premaxillaries* are very short; they curve strongly outwards from the notch and enclose the large anterior narial opening, which is distinctively *crocodilian* (as distinguished from other genera) in shape. The muzzle ends quite sharply. The palatine processes are short and *convex* in both directions, and the incisive foramen is heart-shaped. The alveolus is quite regular in outline; it is pitted in front for the first mandibular teeth, but there is no perforation for them.

The teeth are short, stout, compressed so as to form cutting-edges, and are somewhat obtuse. They are finely striated from base to tip. The premaxillary held four teeth; these are all broken off, but from their fangs it appears that they formed an uninterrupted row, and were subequal in size. The maxillary accommodated fifteen teeth, of which the fifth is the largest, and forms a very prominent canine. The posterior maxillary teeth are proportionately larger, and more equal than in either crocodile or alligator.

The *nasals* are rather broad; they send processes into the anterior narial opening, which tend to divide it, but this division was probably not complete. The limits of the *prefrontals* and *lachrymals* are so obscure as to preclude description.

The *frontals* are long and very narrow, though wider than in the alligator. They are smooth and flat, exhibiting no concavity on top. They expand considerably at the posterior part of the orbit, at the sutures with the post-frontals. These bones are long, stout, and curved very strongly outwards.

The *mastoids* are of remarkable size; they project far backward along the tympanic, and encroach largely upon the occipital region. It is partly owing to this that the occiput is so high.

The *parietals* are short, and very narrow between the temporal orifices, behind these they expand considerably. The orbits are large and of irregular shape.

The *malar* is long and rather slender.

Measurements.

	M.
Length from occipital border to end of muzzle	·455
Breadth of cranium at postorbital angles	·0935
Breadth of cranium between temporal orifices	·019
Breadth of forehead between orbits	·036
Breadth of temporal orifices	·037
Fore-and-aft diameter of the same	·038
Fore-and-aft diameter of the orbits	·073
Length of face in advance of the orbits	·3055
Breadth of face outside of the fifth maxillary tooth	·176
Breadth of muzzle as formed by premaxillaries (about)	·114
Breadth of muzzle at notch for canine	·093
Length of premaxillaries to notch	·080
Estimated length of entire alveolar border	·283
Breadth of articular surface of quadrate	·059
Vertical height of occiput	·124
Vertical diameter of foramen magnum	·016
Transverse diameter of foramen magnum	·025
Vertical diameter of condyle	·023
Transverse diameter of condyle	·028
Length from palatine foramen to end of pterygoid	·120
Length of palatals	·1295
Length of palatine foramen	·142
Greatest breadth of palatine foramen	·051
Length of bony palate from incisive foramen to posterior nares	·350

The *mandible* is long, rather shallow, but very thick. The symphysis is very long, extending as far as the seventh tooth. The chin is quite sharp, but becomes broad, as the rami diverge quite rapidly. The alveolar border is rounded and comparatively straight, the median enlargement of the dentary is in thickness rather than in height. The two rami diverge at an angle which is more open than in the true crocodiles, and less so than in the alligator. The mandibular foramen is smaller than in the latter genus, but corresponds with it in position; it has its long diameter parallel with, and not oblique to, the alveolus. The mandibular fossa is extremely large and deep. The splenial is long and stout, ends obtusely, and does not reach the symphysis. The articular cavity is broad from side to side, but rather shallow; it is not divided into two distinct facets as in the alligator. The post-glenoid process is very stout; it projects but slightly upwards, less so than in either crocodile or alligator. It has no median ridge as in the former genus, and is tuberous at the end.

The teeth are much like those of the upper jaw, but are somewhat sharper and more conical; they are not recurved, and have no distinct constriction, as is found in most of the recent species. There are about eighteen teeth to each ramus; the first is large and sharp, and is followed by two small ones and then by the canine. The remaining teeth do not exhibit any great differences of size.

Measurements.

	M.
Length of rami (straight)	·618
Width of lower jaw outside of glenoid cavities	·316
Length of symphysis	·110
Width of jaw at second enlargement	·057
Depth at oval foramen	·073
Greatest width at symphysis	·110
Space occupied by teeth	·340
Breadth of glenoid cavity	·072
Length of post-glenoid	·065

Vertebræ.

Cervicals.—The centra are long and nearly cylindrical, expanding slightly near the anterior face. The hypapophyses are short and broad; they project forwards, and are somewhat compressed. The vascular foramina correspond in size and position to those of the alligator. The neural canal is small and subcircular, having comparatively short but very stout neurapophyses, which are perforated behind the diapophyses. These are short and stout, and are developed from the neurapophyses alone. The zygapophyses are long and flat; the anterior ones project almost vertically. The neural spines are stout, and of greater antero-posterior extent than in the alligator.

Dorsals.—A few of the anterior dorsals have strong hypapophyses. The centra of all are long and stout. The neural canal is smaller than in the cervical region; it has strong neurapophyses, which develop long and depressed diapophyses. The neural spines are low and broad. The zygapophyses are developed on the laminæ, and do not project upwards as in the cervical region.

The *lumbars* are much like the dorsals, except that they are longer, and have very large and depressed diapophyses, which project somewhat upwards.

Measurements.

	M.
Length of centrum of a posterior cervical	·049
Height of neural canal	·015
Fore-and-aft diameter of neural spine	·023
Length of diapophysis	·023

Dorsal.

	M.
Length of centrum	·0555
Length of hypapophysis	·018
Fore-and-aft diameter of neural spine	·030

Lumbar.

	M.
Length of centrum	·057
Fore-and-aft diameter of neural spine	·0285
Diameter of diapophysis	·029

The dermal scutes are long ellipses, deeply pitted on one side, but without a trace of a keel. Their edges show no signs of sutural union.

The bones described indicate a reptile about fifteen feet long. They were found near Smith's Fork, Wyoming.

CROCODILUS PARVUS, *sp. nov.*

A small reptile represented by sixteen vertebræ and a portion of the pelvis.

The *cervicals* have short centra, with very deep articular cups and hemispherical heads; the latter have a prominent rim around the base. The hypapophyses are short, stout, and very nearly vertical in direction; the sides of the centra are channelled by a deep vertebraterial canal; the parapophyses are developed very low down, and are very prominent. The diapophyses are developed partly from the centra and partly from the neurapophyses; they are stout and very short. The facets for the ribs are developed in the usual place. The neural arch is rather high, and forms a small, narrow canal; the proportions of the neurapophyses and neural spines are about as in *Alligator mississippiensis*, but the zygapophyses are not so prominent.

The *dorsals* show a considerable increase in size over the cervicals; the centra become elongate, and the articular cups shallower and transversely oval. Several of the anterior vertebræ retain large hypapophyses. In the dorsal region the diapophyses are developed from the neurapophyses alone, and at a considerable height above the neuro-central suture; they are long and depressed. The zygapophyses and neural spines present no peculiarities of structure.

In the *lumbar* region the vertebræ regain their cylindrical form, and become still more elongate; but the cups are comparatively shallow and the heads low; there is no distinct shoulder. The neural canal is small, with low, broad neurapophyses, from which are developed very broad and depressed diapophyses, which project outwards in a horizontal plane. The neural spines are thick, and broad antero-posteriorly, but are so broken that their height cannot be determined.

In both dorsal and lumbar region the neurapophyses are deeply notched on their posterior edges, and close to the neuro-central sutures, for the passsage of the spinal nerves.

The *ilium* is very high compared with most crocodiles; its vertical diameter is considerably more than half of the antero-posterior diameter. The construction of the bone is very much like that in the modern *Crocodilia;* but the suprailiac border is more regular, and the anterior tuberosity is not so thick or so much everted as in these forms. The acetabulum is small, shallow, directed downwards and outwards, and situated considerably forward of the median line. The iliac surface is smooth, but very irregular, being very deeply concave above the acetabulum, and convex behind it. The sacral surface is rugose, rises above the sacrum, and shows attachments for two sacral vertebræ. Thus the construction of the entire pelvis shows but very little variation from the modern type.

Measurements.

	M.
Antero-posterior diameter of ilium	·095
Vertical diameter of ilium	·061
Antero-posterior diameter of acetabulum	·029
Length of centrum of third (?) cervical vertebra (from edge of cup to tip of ball)	·032
Height of neural canal, third (?) cervical	·0095
Length of hypapophysis of third cervical	·0085
Length of centrum of a posterior dorsal	·040
Length of diapophysis (about)	·032
Length of centrum of a lumbar	·046
Vertical diameter of a lumbar	·029
Breadth of neurapophysis of a lumbar	·027

CROCODILUS HETERODON, Cope.

Alligator heterodon, Proc. American Philosophical Society, 1872, p. 544.

Represented by a single tooth from the posterior part of the mandibular series. It agrees very closely with the corresponding tooth of *Alligator mississippiensis*, but presents some differences. The crown is very low, obtuse, and finely striate; it is compressed and shows a cutting-edge. Its longest diameter is fore and aft; both this and the transverse diameter are proportionately greater than in the modern species. The constriction of the neck is very decided; the fang is large, and especially thick.

Measurements.

	M.
Fore-and-aft diameter of crown	·010
Transverse diameter of crown	·007
Vertical height of crown	

CROCODILUS CLAVIS, Cope.

U. S. Geol. Survey of Terrs. 1872, p. 612.

This species is indicated by the remains of a crocodilian larger than *Crocodilus Elliotii*, but very different from it. The pitting of the dermal scutes, and of all the cranial bones, is deeper than in any other of the Bridger crocodilians in our possession, and very strongly resembles that in *Alligator mississippiensis.*

The *mandible* has a long symphysis, and the alveolar border shows the sudden deep depression just behind it, which is so marked in the ordinary alligator. The rami, however, do not diverge at such an open angle. The jaw is very stout, and is deeper and thinner than in *Crocodilus Elliotii;* and is of about the same proportionate thickness, but deeper than in the alligator. The splenial ends obtusely, and approaches the symphysis somewhat more closely than in the alligator, but does not enter into its formation. The teeth are stout and obtusely conical, not striate, and implanted very close together; they exhibit about the same alternation of size as do those of the alligator. What appears to be the canine is small; it is preceded by a much smaller, and succeeded by a slightly smaller tooth. The dermal scutes are quadrate in shape; they are deeplyand irregularly pitted, and have a low but distinct longitudinal keel; they are suturally united by their lateral borders.

CHELONIA.

The Bridger beds have yielded a great abundarce and variety of land, marsh, and fresh-water chelonians. They present much variation of form and size; and, owing to the great pressure in the strata, scarcely any two specimens of the same species are alike; occasionally, however, an undistorted specimen is obtained.

The most abundant remains of turtles are those of a species of the recent genus *Emys*, which are found in all the beds, and are, perhaps, the commonest fossils of the basin. The genera *Trionyx* and *Hadrianus* (*Testudo*, Leidy) follow next in order.

HADRIANUS, Cope.

Resembles *Testudo* in form, but has two analscuta, as have most *Emydidæ*.

HADRIANUS ALLABIATUS, Cope.

U. S. Geol. Survey of Territories, 1872, p. 630.

Represented by two ungual phalanges which resemble the claws of *Testudo*, but are proportionately shorter, broader, and not so pointed at the ends. They are oval in section, both longitudinally and transversely; the articular faces are deep and subinferior.

From Henry's Fork.

HADRIANUS OCTONARIUS, Cope.

Geol. Survey of Terrs., 1872. p 630.

Represented by the right humerus of a large individual.

This bone is intermediate in character between the corresponding bones of *Testudo* and *Emys*. The head is longer and narrower than in the former genus; it is implanted on a short, distinct neck, and is strongly convex in both directions. The articular surface extends to the base of the internal tuberosity. The tuberosities, especially the external one, are very large and thick. The external rises above the head, and resembles that of *Emys* in shape. The fossa separating the tuberosities is comparatively narrow. The shaft is much like that of *Emys*, but is somewhat more strongly curved; not so much, however, as in *Testudo*, and the distal end is not so much flattened. The anconeal fossa is wider and deeper than in either genus. The trochlea is broad, and divided by an obscure groove into a small and convex radial face, and a nearly plane (transversely) ulnar face. The condyles are prominent and rugose.

Found near Dry Creek.

EMYS.

EMYS WYOMINGENSIS, Leidy.

Cont. to Ex. Vert. Fauna, p. 140.

Represented by six perfect shells from Cottonwood and Dry Creeks, and Henry's Fork, and a shoulder girdle from Cottonwood Creek, which is provisionally referred to this species.

This species, when adult, was upward of a foot in length, and in the composition of the shell, number of scutes, etc., resembled the living species of the genus.

The Shoulder Girdle has the form characteristic of the *Emydidæ*, but presents some peculiarities. The scapula is short, not being as long as the coracoid, and is not so straight or cylindrical as is usual in *Emys*; but is compressed, and somewhat recurved, and tapers towards the upper extremity, which is marked by a smooth rounded facet for the cartilaginous supra-scapula. The pre-coracoid is long, sub-cylindrical at its origin, but becomes broad and flat distally; at the extremity it is longitudinally striated. The proximal end is flexed forward at an obtuse angle, and is expanded to form the long suture with the scapula and coracoid. It contributes considerably to the glenoid cavity. The coracoid is remarkably long, and after leaving the sutures with the other elements of the girdle, becomes very broad and thin. This is most marked distally. The anterior border is thickened, and the bone is slightly concave on both surfaces.

The three parts of the shoulder girdle are united by distinct bony symphyses; they differ from some of the modern species, in which there is only a ligamentous union between the coracoid and the other parts. It presents a further difference in the long and slender neck which is formed by the flexing of the pre-coracoid, and in the shallow and sub-circular glenoid cavity. The short scapula and long coracoid would indicate a species with a low, broad carapace, as was probably the case in E. *wyomingensis*, though much difficulty has been experienced in determining this point, owing to the distortion of the specimens.

Measurements.

	M.
Length of neck to point between coracoid and precoracoid...........	·0345
Length of coracoid (about).........	·133
Length of precoracoid..	·114
Length of scapula (about)..	·126

BAENA, Leidy.

BAENA UNDATA, Leidy.

Cont. to Ex. Vert. Fauna, p. 160.

Three nearly perfect shells of different ages, from Dry and Cottonwood Creeks.

TRIONYX, Geoffr.

TRIONYX UINTAENSIS, Leidy.

Cont. to Ex. Vert. Fauna, p 176.

Cottonwood Creek.

PISCES.

TELEOSTEI.

TELEOCEPHALI.

CYPRINODONTIDÆ.

"Head and body covered with scales; barbels, none. Margin of the upper jaw formed by the premaxillaries only. Teeth in both jaws; upper and lower pharyngeals, with cardiform teeth. Dorsal fin situated on the hinder half of the body." (GÜNTHER.)

TRICOPHANES, Cope.

U. S. Geolog. Survey of the Terrs., 1872, p. 641.

Having secured a very perfect specimen of this genus, we are enabled to complete the definition of its generic characters. We give, then, Professor Cope's definition, with some emendations and additions: Dorsal and anal fins short; ventral fin sometimes beneath and sometimes in advance of the dorsal. The premaxillary forms all of the superior arcade of the mouth, which has a wide gape, opening back behind the orbit. This bone has a row of long, slender, recurved, and subequal teeth implanted in it. The dentary is stout, and has a few small teeth. The branchiostegal rays are six in number, and are rather wide. The preoperculum is serrate. The operculum is ridged on top. The anterior vertebræ are unmodified, and the centra are not elongate. A strong acute spine supports the dorsal, and a similar one the anal fin. There is a long post-clavicle, which may or may not extend to the base of the ventral parallel with the femur. The femur is long and furcate; the external part straight and reaching to the clavicle; the internal curves to meet the corresponding portion of its fellow. The ventral radii are eight in number, and the caudal fin is furcate. The scales are peculiar, and characteristic of the genus. They are very thin, and have borders fringed with long, close-set, bristle-like processes. This genus includes as yet only three species: *T. hians*, from Osivio, Nev.; and *T. foliarum* and *T. Copei*, from Florissant, Col.

TRICOPHANES COPEI, *sp. nov.*

Vertebræ D. 12, C. 18, Radii D. 14, A. 8, V. 8, C. 41, P. 5 only visible, not all preserved. The dorsal fin is long, and projects beyond the beginning of the anal fin; the mouth is terminal, and the muzzle rather sharp. All the bones of the skeleton are very slender; and this is especially true of the ribs, which are not as thick as the interneurals. The neural and hæmal spines are short and slender. The origin of the dorsal is nearer to the muzzle than to the caudal; though, as a whole, the fin is on the hinder half of the body. There are no interneural spines in front of the dorsal fin; those supporting the fin are short, slender, and without the laminar expansions found in *T. foliarum*. The caudal fin consists of numerous jointed rays, which are supported by the neural and hæmal spines of the last three vertebræ. The scales are small, and exhibit the peculiarities of the genus, but the rows are too imperfect to be counted.

Measurements.

	M.
Total length (straight)	·0935
Length of head	·018
Length of vertebral column	·055
Length of caudal fin	·024
Length of dorsal spine	·011
Length of anal spine	·009
Depth of head posteriorly	·016
Length of mandibular ramus	·010
Length to dorsal fin (from muzzle)	·033
Length of dorsal fin	·0135
Depth of body at middle of dorsal fin	·017

Found in the insect beds at Florissant, Col.

CATOSTOMIDÆ.

Body covered with scales; head naked; margin of upper jaw formed by the premaxillaries; mouth toothless. Pharyngeal teeth in a single series, and exceedingly numerous and closely set. Dorsal fin elongate and opposite the ventrals. Anal short, or of moderate length.

AMYZON, Cope.

U. S. Geolog. Survey of the Terrs., 1872, p. 642.

Allied to *Bubalichthys.* Dorsal fin elongate, with a few fulcral spines in front. There are three broad branchiostegals. The vertebræ are short, and the hæmal spines of the caudal fin are distinct and rather narrow. The teeth are arranged comb-like, are truncate, and number from thirty to forty. The dentary bone is slender and toothless, and the angular is distinct.

AMYZON COMMUNE, Cope.

U. S. Geolog. Survey of Terrs., 1873, p.

Represented by several fine specimens from near Castello's Ranch, Col.

SAURODONTIDÆ.

For a very complete definition of this family, see Cope's Cretac. Vert., p. 183.

PORTHEUS, Cope.

Cretac. Vert., p. 189 *et seq.*

"Teeth subcylindric, without serrate or cutting edges, occupying the maxillary, premaxillary, and dentary bones: size, irregular; premaxillary, median maxillary, and dentary much reduced. No foramina on inner face of jaws. Teeth on the premaxillary reduced in number. Opercular and preopercular bones very thin. Cranial bones not sculptured."

PORTHEUS THAUMAS (?), Cope.

Loc. cit. p. 196.

Maxillary large, teeth three; third mandibular small, without cross groove in front of it.

A single tooth from the cretaceous sandstone of Cement Gulch, Col., is provisionally referred to this species; the reference cannot be certain, as the specimens described and figured by Professor Cope have the crowns of the teeth broken. The tooth is not so long as the largest tooth of *P. molossus*, but is of proportionately greater diameter and not so straight. It is conical and recurved, and shows two very obscure cutting-edges, which divide the crown into two unequal faces. It has faint longitudinal striations on all sides, and the apex is sharp.

Measurements.

	M.
Fore-and-aft diameter at the base	0·013
Height of crown	0·020

NEMATOGNATHI.

SILURIDÆ.

"Skin naked, or with osseous scutes, but without scales. Barbels always present; maxillary bone rudimentary, margin of the upper jaw formed by the premaxillaries only. Suboperculum absent; adipose fin present or absent." (Günther.)

RHINEASTES, Cope.

U. S. Geol. Survey of the Terrs., 1872, p. 638.

A genus allied to the recent *Ichthælurus* but differing in the inferior grooving of the vertebræ and in the rough exostoses of the cranial bones. It differs from *Phareodon* in having the usual band of bristle-like teeth on the dentary.

RHINEASTES ——?

Represented by a portion of the dentary and hyomandibular bones of a large cat-fish from Bridger Butte.

The dentary is broad and shallow, grooved below, and deeply striated on the external face. As much of it as is preserved is straight. The teeth are small, subequal throughout, and very numerous. The hyomandibular is broad and thick, and has a striated surface. The condyle is peculiar in having two separate articular faces above and below, one convex andthe other flat.

GANOIDEI.

CYCLOGANOIDEI.

AMIIDÆ.

"Scales cycloid; a long, soft dorsal fin. Abdominal and caudal parts of the vertebral column subequal in extent." (Günther.)

AMIA.

Body elongate subcylindrical, compressed behind; snout short and rounded. Jaws with an outer series of closely-set pointed teeth, and with a band of small teeth; similar teeth on the vomer, palatine, and pterygoid bones. Long dorsal, short anal, and rounded nonfurcate caudal fin. Ventrals well developed. A single large gular plate; branchiostegal rays ten to twelve.

AMIA (Protamia) UINTAENSIS, Leidy.

Cont. to Ext. Vert. Fauna, p. 185.

A species of large mud-fishes related to the modern *Amia calva.* The vertebræ are all much wider than they are high. The articular cones have their bottoms considerably above the centre, and are minutely perforate for the notochord. The centrum is transversely curved from side to side, and has the convexity directed forwards; it is truncate below, making the infero-lateral angles quite prominent in the anterior dorsal region; in the posterior there are two fossæ. The diapophyses are large, but almost sessile, and take their origin above the centre, on the same line as the bottom of the articular cone. The facets for the neurapophyses are in the form of the figure 8; their internal borders are prominent. The atlas has a broad oval centrum, which is not truncate below, and has no markings of any kind on the under surface. The articular faces for the neurapophyses are prominent, and approach near together. The depression for the occipital condyle is small, circular, and situated above the centre.

From Henry's Fork.

AMIA DEPRESSA (?), Marsh.

Pr. Ac. Nat. Sc. 1871, p. 103

In this species the dorsal centra are wide, low, and short, and of a regular oval outline. The articular cones are shallow, and have their bottoms but slightly above the centre. The neurapophysial facets are deep, with prominent borders, and the diapophyses are sessile. The chief peculiarity is that the under surface of the centrum has no markings of any kind.

Measurements.

	M.
Length of centrum	·010
Breadth of centrum	·040
Depth of centrum	·027

As Professor Marsh has given no measurements, the reference to *A. depressa* cannot be certain.

The specimen was found at Henry's Fork.

AMIA SCUTATA, Cope.

Bull. of U. S. Geol. Survey, No. 1 of Series II, p

A species of about the size of *A. calva*, but with a proportionately larger head. It is represented in our collection by a specimen which lacks only a portion of the caudal and pectoral fins. The *premaxillary* is short and stout, articulates closely with the maxillary, and bears a single row of pointed recurved teeth. These are shorter and straighter than in *A. calva.* The *maxillary* is much as in the modern species, but is rounder. The cranio-facial axis is straight and broad; the *basioccipital* is the largest of the bones; the *basisphenoid* and *presphenoid* are of the usual shape and size, but there is a constriction at their junction which is not marked in the modern species. The *vomer* is long and double, and at the extremity is armed with rows of small teeth. The two portions diverge more perceptibly than in *A. calva*, and are stouter, though this appearance may, to some extent, be due to flattening.

The *frontal* is long, broad, and thick; the upper surface is delicately sculptured in a somewhat different pattern from that seen in the modern species. The *parietal* is short and broad, while the *epiotic* is unusually narrow. The *mandible* is long and slender; the rami are incurved anteriorly, but apparently not to the same extent as in *A. calva.* The articular has the shape of a long and narrow wedge; it does not form a very close articulation with the dentary. The dentary is long and comparatively slender, has a rounded outline, and is occupied by an external row of large, and an internal band of small teeth. The mandibular teeth, like those of the upper jaw, are somewhat different from the teeth of *A. calva;* they are shorter, stouter, and are not so much incurved or recurved. They are very sharp, and show a constriction below the apex. The small teeth are of the usual size and shape. The jugular plate is well developed, and is long and narrow. The *hyoid arch* is very much the same as that shown in the recent species; the characteristic flat branchiostegals are well marked; they appear to be thirteen in number.

The *scapular arch* is long and stout. The *clavicle* is strongly bent, the *supra-clavicle* is short, and the *post-clavicle* is long. The pectoral fin is too indistinct for description.

The *vertebræ* are of considerable depth in the anterior dorsal region, and decrease steadily in size as they go backwards. The neural spines are long and slender, and project strongly backwards. The relation of the centra to the arches seems to be about that seen in *A. calva*, but the neurapophyses are more slender. The diapophyses are long and slender, in this respect differing from the Bridger species and approaching the modern one. The dorsals are thirty-five in number. The caudals number about forty-seven. They have smaller centra, but longer and stronger neurapophyses than the dorsals. The hæmal arch is long, and the hæmapophyses articulate movably with the centra. The spines supporting the caudal fin rays are very stout. The dorsal fin is long and soft, and has long interneurals supporting short rays; these are fifty-three in number. The anal fin, on the other hand, is very short, having but nine rays, which are long and jointed, and articulate with short interhæmals. The caudal fin appears to be of the usual form. The *femur* is of the general shape characteristic of *Amia*, but is not just like that of *A. calva.* It is shorter, broader at the proximal end, while the distal end is narrower, and has a deeper constriction just above it. The ventral fins are placed under the middle of the dorsal region, and have each ten rays. The scales are of the usual cycloidal shape, and minutely striate.

Measurements.

	M.
Total length (estimated in part)	·404
Length of head	·093
Length of vertebral column	·253
Length of caudal fin (estimated)	·058
Length of mandible	·059
Length of jugular plate	·032
Length of dorsal region	·141
Length of caudal region	·112
Depth of body at origin of dorsal fin	
Length of dorsal fin	·117
Length of femur	·027

From the insect beds near Florissant, Col.

PAPPICHTHYS, Cope.

U. S. Geol. Survey of the Terrs., 1872, p. 634.

Vertebræ short, dorsal with projecting diapophyses. Maxillary and dentary bones support but one series of teeth.

PAPPICHTHYS PLICATUS, Cope.

Loc. cit., p. 635.

From Henry's Fork.

PAPPICHTHYS LÆVIS, Cope.

Loc. cit., p. 366.

Represented by three vertebræ from the posterior part of the dorsal region. The centra are subcircular and have deep articular cones, with their bottoms above the centre, and minutely perforate for the notochord. The centra are comparatively quite long, and have prominent projecting rims, and are truncate beneath. The facets for the neurapophyses are long, and are separated into two parts for the contiguous arches. The diapophyses are short and stout.

Measurements.

	M.
Length of centrum	·015
Breadth of centrum	·0315
Depth of centrum	·027

Found at Henry's Fork.

PAPPICHTHYS SYMPHYSIS, Cope.

Loc. cit., p. 636.

Found at Cottonwood Creek.

ELASMOBRANCHII.

PLAGIOSTOMATA.

CARCHARIDAE.

"Eye with a nictitating membrane. An anal fin; two dorsals."

GALEOCERDO.

Caudal fin with a double notch; mouth crescent shaped; teeth subequal in both jaws, oblique, serrate on both margins.

GALEOCERDO FALCATUS, Ag.

Corax falcatus, Poiss. Foss., t. iii., p. 226.

This species is represented by a single tooth from the cretaceous sandstone near the Garden of the Gods, Col. It does not agree exactly with any descriptions or plates which we have seen; but the differences are probably owing to the position or age of the specimen. The crown is low, broad, and not very acute, the edge is finely serrate, and there is no sensible difference between the serrations of the two borders. The anterior border is undulating in outline, but for the most part is convex; the posterior is short and straight, and sends out quite a long heel. One face of the crown is flat and the other is strongly convex. The root is stout and divided into two fangs, which are longer and more distinct than is common in this species. There are no denticles; cementum smooth.

Measurements.

	M.
Length of crown	·017
Depth of fang	·009
Height of crown	·011

GALEOCARDO HARTWELLII, Cope.

Cret. Vert, p.. 244.

This species belongs to the group *G. Egertonii*, Ag., having the two edges subequal and symmetrical. A single tooth from Cement Gulch, Col.

CESTRACIONTIDÆ.

"Two dorsal fins, an anal; nasal and buccal cavities confluent. Teeth obtuse, several series being in function." (Günther.)

PTYCHODUS, Ag.

Poissons Fossiles, t. iii., p. 56.

PTYCHODUS WHIPPLEYI, Marcou.

Geology of North America, 1858, p. 33.

Represented by a tooth from the cretaceous of Cement Gulch, almost identical with the specimen described by Dr. Leidy from the cretaceous of Texas. (Cont. to Ext. Vert. Fauna, p. 300.)

SUMMARY.

MAMMALIA.

PRIMATES	4	
CARNIVORA	2	
PERISSODACTYLA	16	
ARTIODACTYLA (?)	1	
AMBLYPODA	3	
RODENTIA	1	
		—27

AVES.

INCERTÆ SEDIS	4	
		— 4

REPTILIA.

CROCODILIA		
CHELONIA	5	
		—11

PISCES.

TELEOCEPHALI	3	
NEMATOGNATHI	1	
CYCLOGANOIDEI	6	
PLAGIOSTOMATA	3	
INCERTÆ SEDIS	1	
		—14
Total		56

108

EXPLANATION OF PLATE A.

Figure about one fourth natural size

UINTATHERIUM LEIDIANUM.

112

EXPLANATION OF PLATE I.

Figure three fourths natural size.

PALÆOSYOPS PALUDOSUS.

Posterior view of cranium.

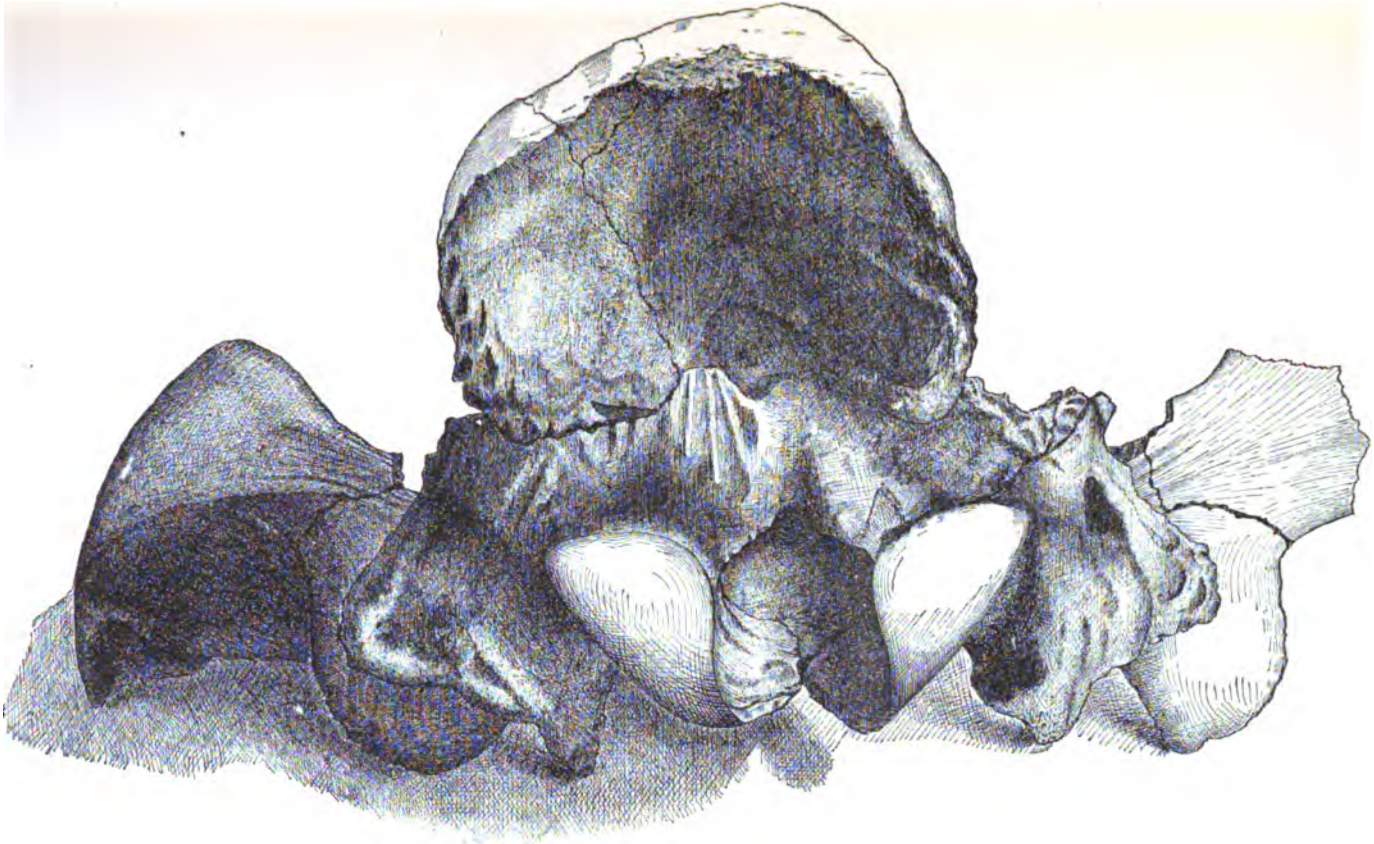


PLATE I.

114

EXPLANATION OF PLATE II.

Figures one fourth natural size.

PALÆOSYOPS MAJOR.

Fig. 1.—Axis, view of right side.

Fig. 2.—Axis, anterior view.

Fig. 3.—Atlas, posterior view.

Fig. 4.—Atlas, anterior view.

Figs. 5 and 6.—Seventh cervical anterior and posterior views

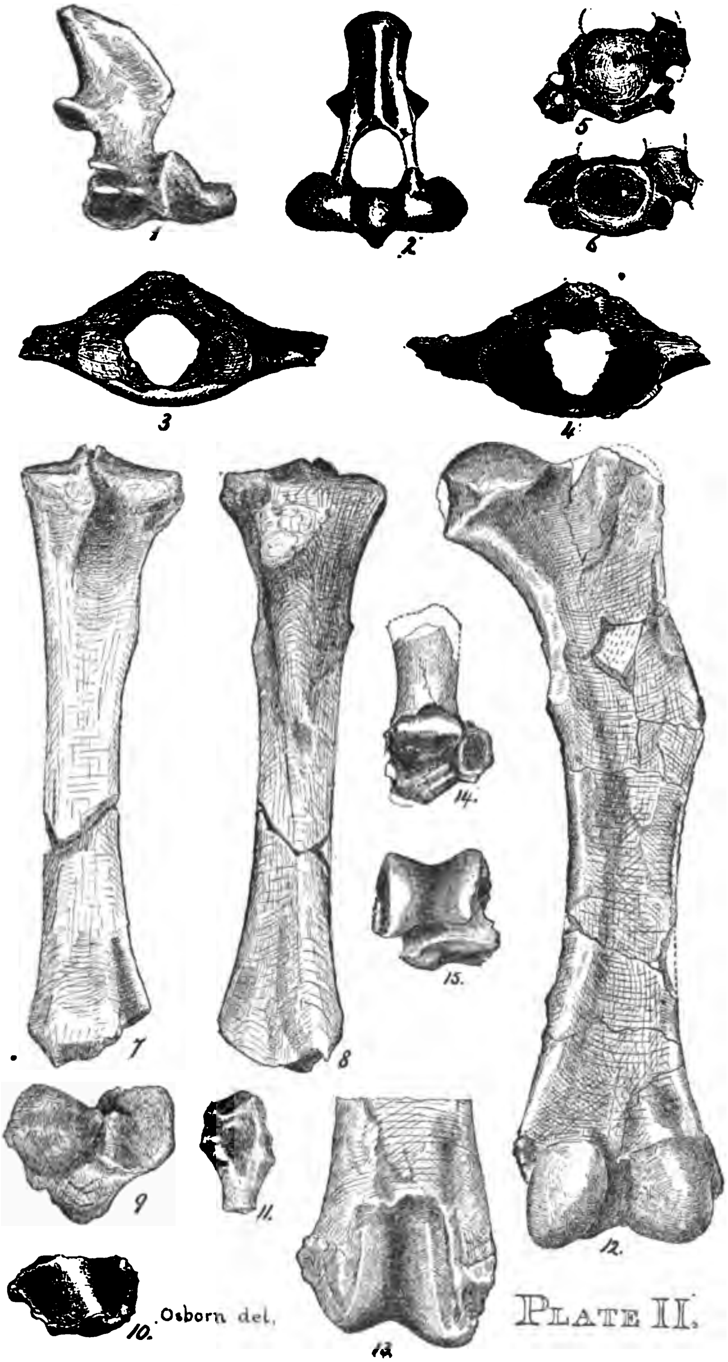
Figs. 7 and 8.—Anterior and posterior views of right tibia.

Figs. 9 and 10.—Proximal and distal faces of same.

Fig. 11.—Proximal end of fibula.

Fig. 12.—Right femur, posterior view.

Fig. 13.—Trochlea of the same.



Osborn del.

PLATE II.

EXPLANATION OF PLATE III.

Figures one half natural size.

PALÆOSYOPS PALUDOSUS.

Figs. 1 and 2.—Ulna, anterior view, and distal articular face of same.

Figs. 3, 4, and 5.—Radius, anterior view; and distal and proximal faces of same.

Fig. 6.—Left scapula.

Fig. 7.—Right humerus, proximal end, anterior view.

Fig. 9.—Left manus, anterior view.

PALÆOSYOPS MAJOR.

Fig. 8.—Left humerus, anterior view.

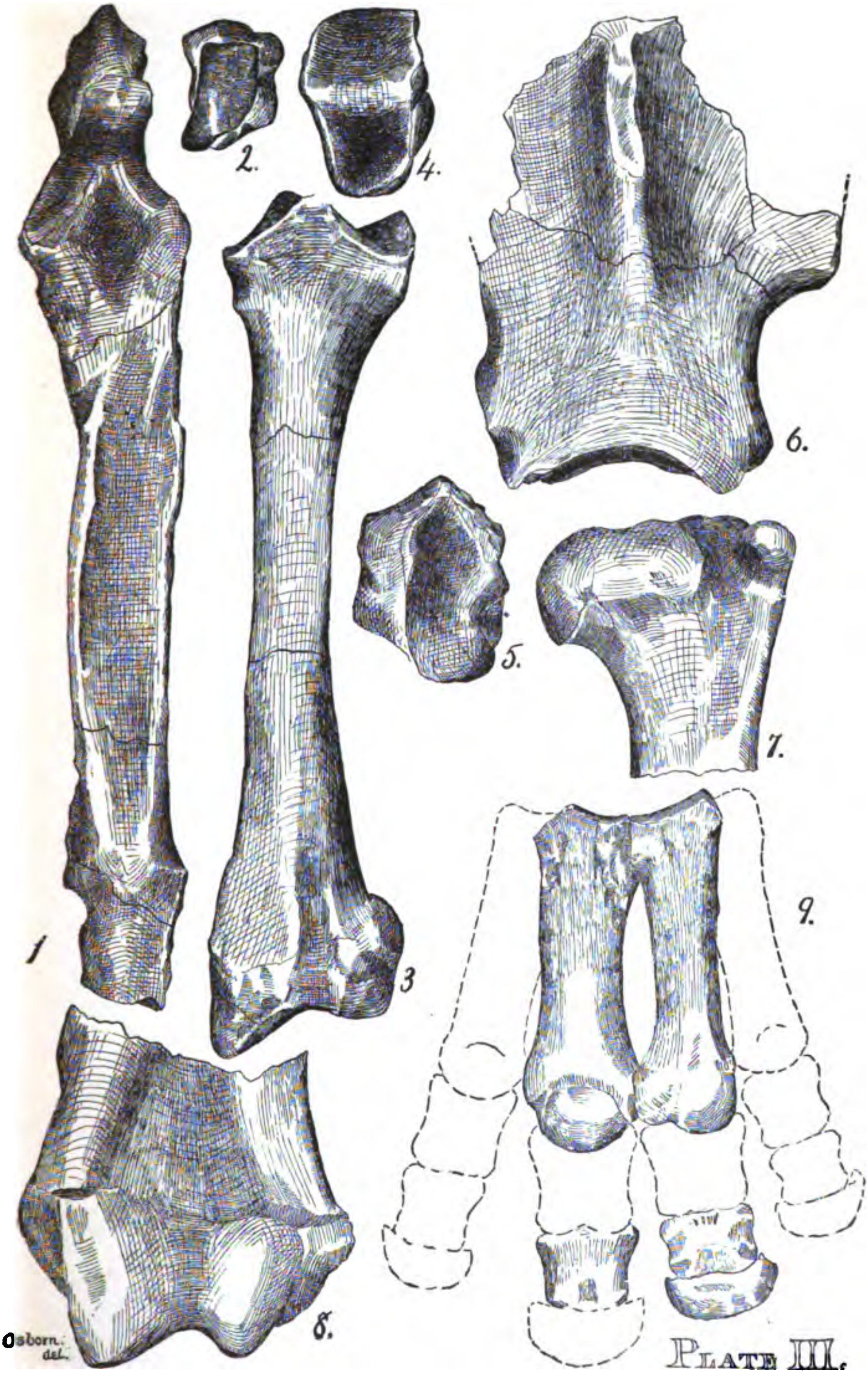


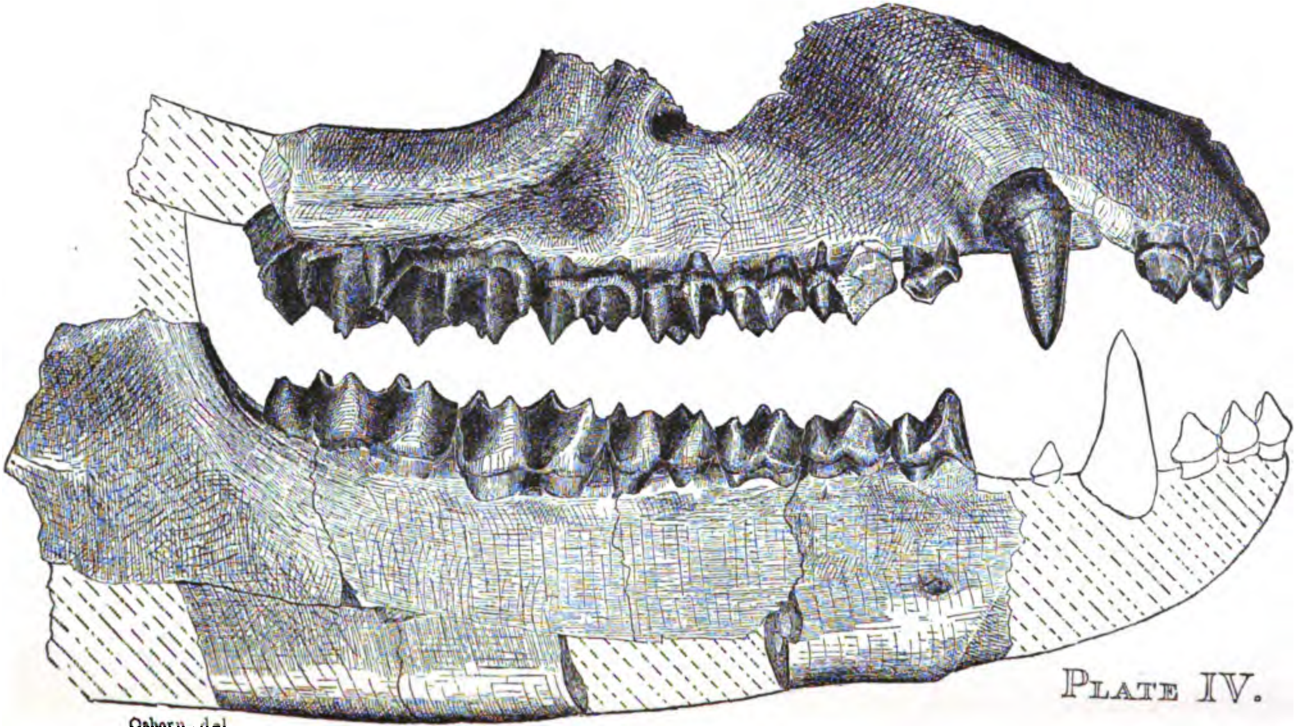
PLATE III.

EXPLANATION OF PLATE IV.

Figure one half natural size.

LEUROCEPHALUS CULTRIDENS.

Upper and lower jaws. View of right side. Dotted outlines indicate probable position of lower incisor and canine series.



Osborn, del.

PLATE IV.

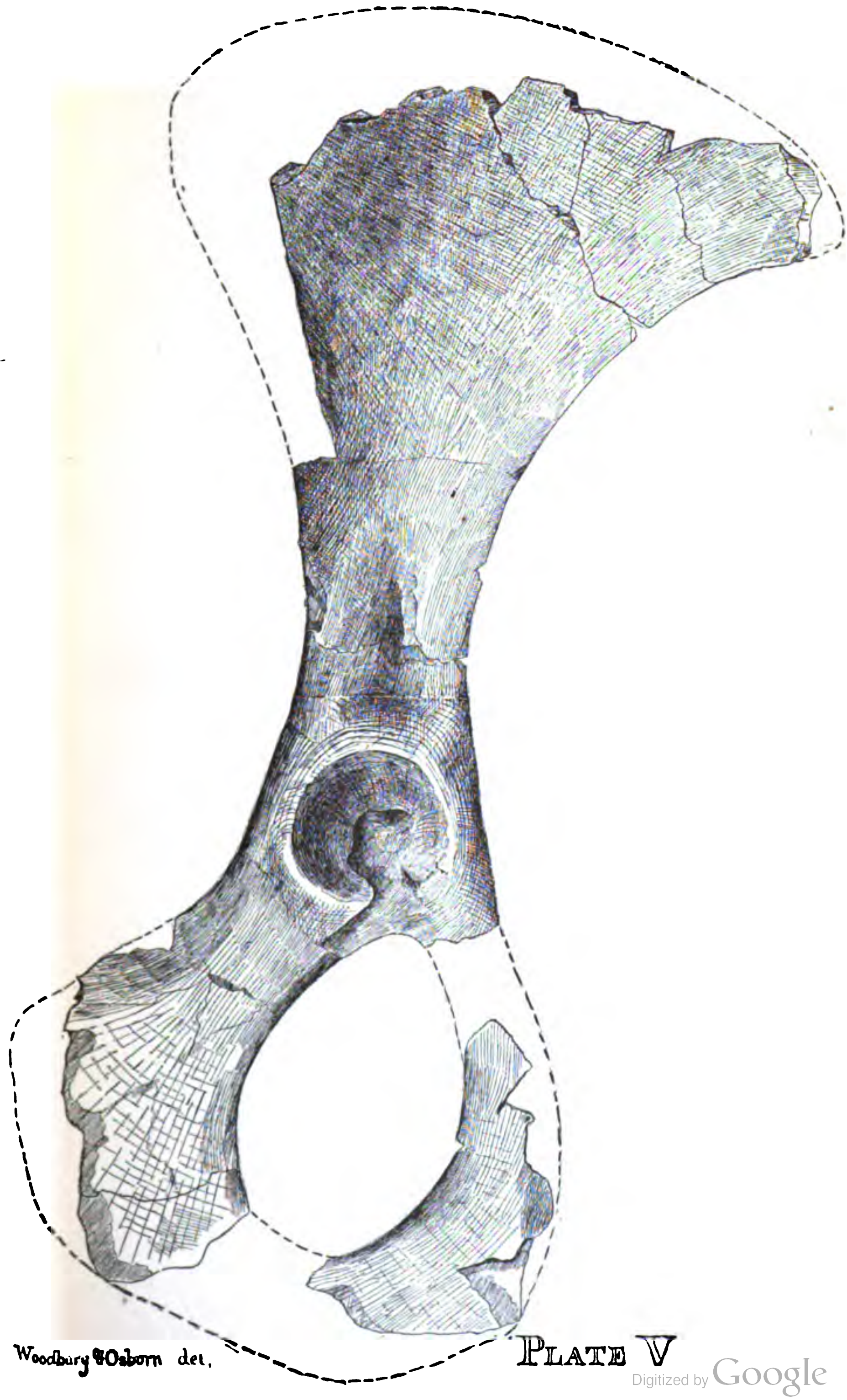
120

EXPLANATION OF PLATE V.

Figure one half natural size.

PALÆOSYOPS MAJOR.

Right innominate bone. The iliac crest and position of pubis estimated in outline.



Woodbury & Osborn del.

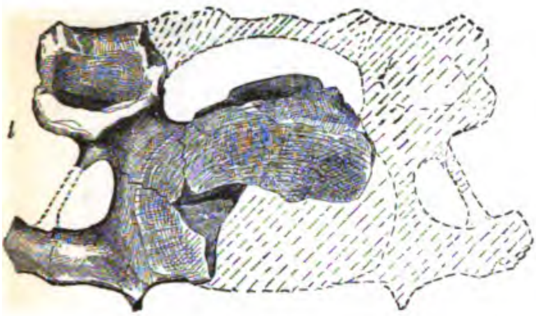
PLATE V

EXPLANATION OF PLATE VI.

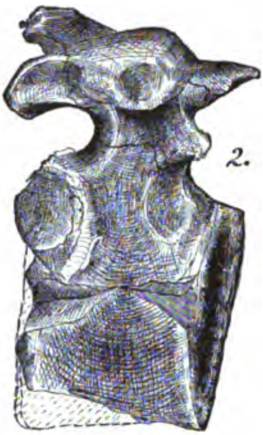
Figures one third natural size.

UINTATHERIUM LEIDIANUM.

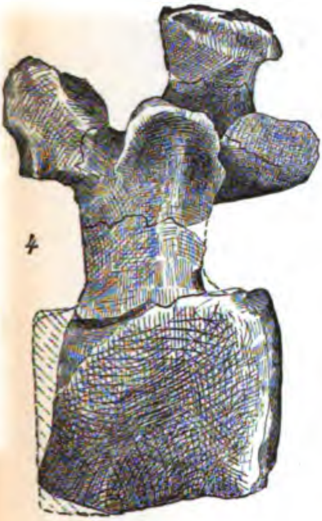
Fig. 1.—Cervical vertebra, fifth or sixth, anterior view.
Fig. 2.—Dorsal vertebra, anterior region, view of left side.
Fig. 3.—Dorsal vertebra, middle region, posterior view.
Fig. 4.—Last lumbar vertebra, view of right side.
Fig. 5.—Last lumbar vertebra, posterior view.
Fig. 6.—Caudal series, first four vertebrae.



1



2.



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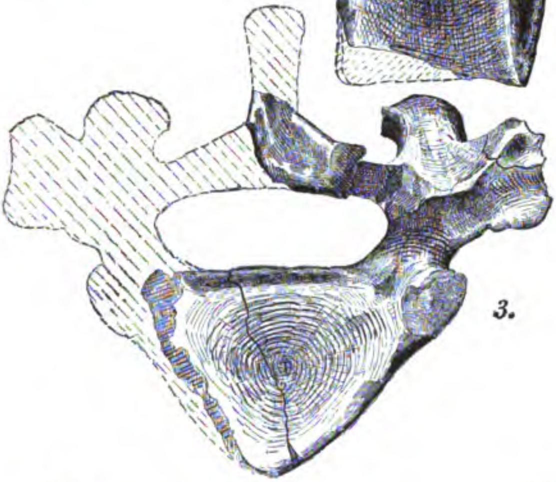
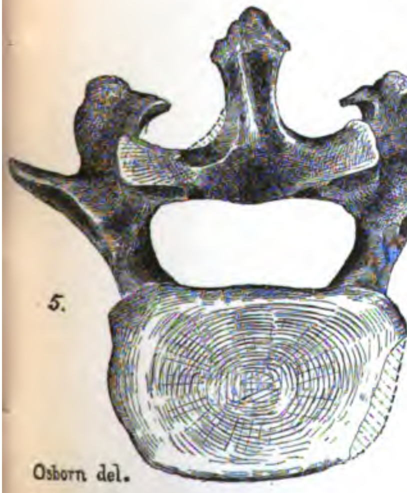
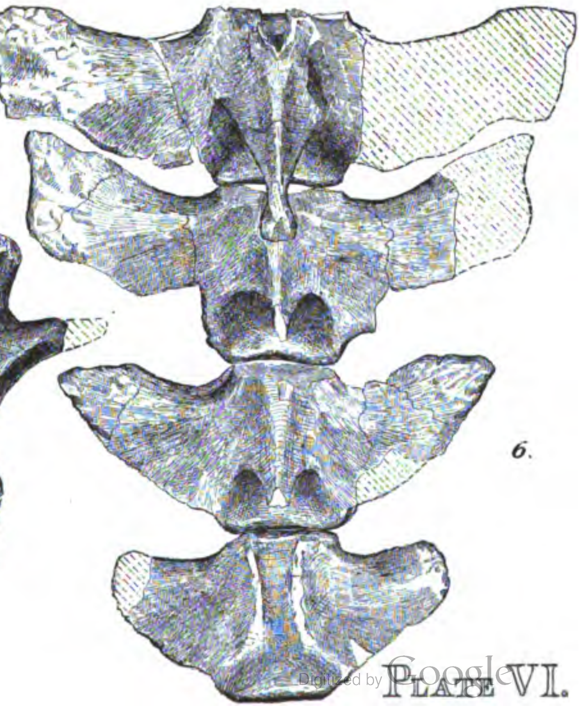


3.



5.



6.

Osborn del.

PLATE VI.

EXPLANATION OF PLATE VII.

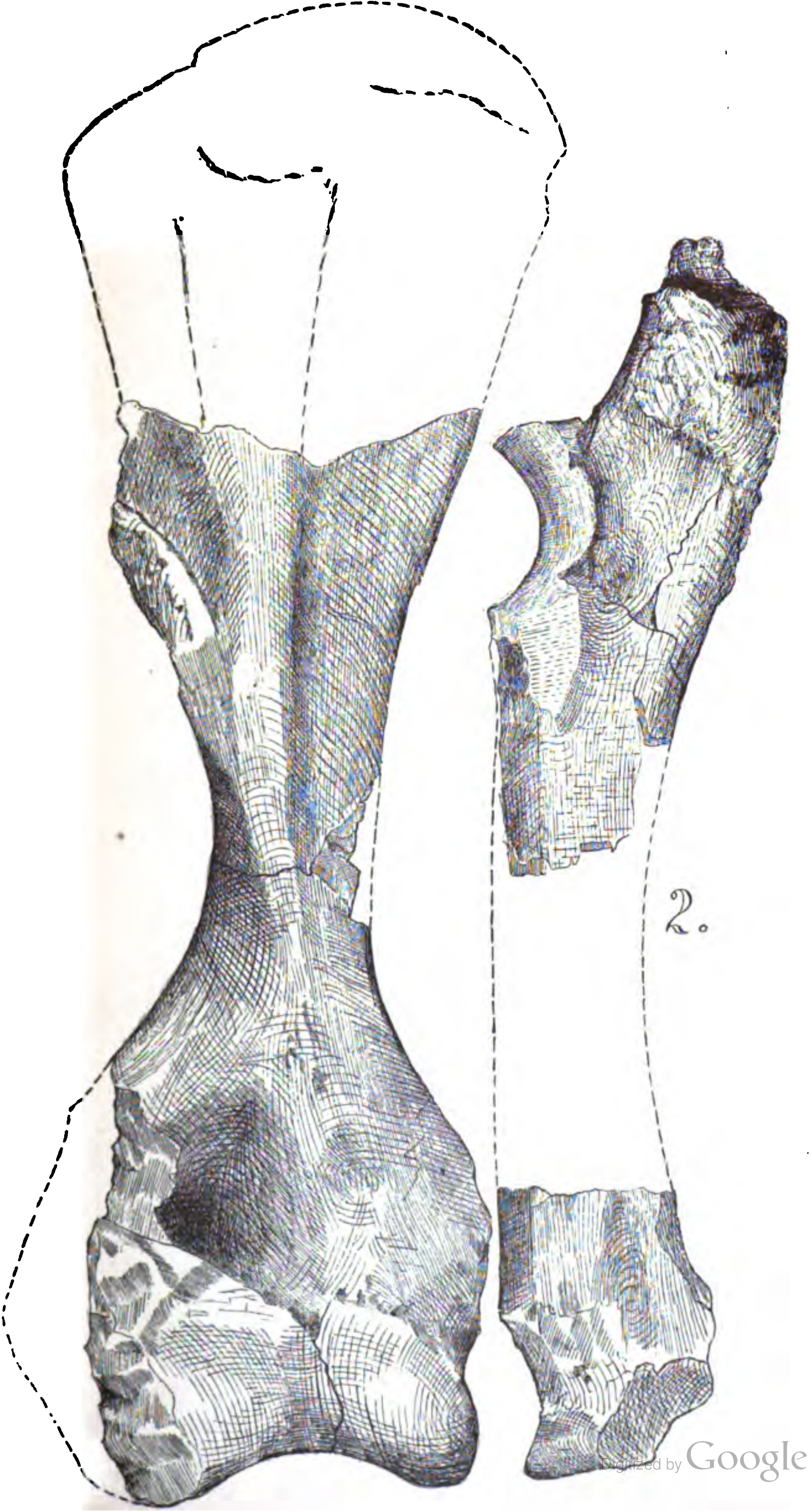
Figures one third natural size.

Uintatherium Leidianum.

Fig. 1.—Anterior view of right humerus.

Fig. 2.—Ulna, side view, length estimated.

PLATE VII.



EXPLANATION OF PLATE VIII.

Figures one third natural size.

UINTATHERIUM LEIDIANUM.

Fig. 1.—Right scapula. The dotted outline gives an attempted restoration of the original shape.

Fig. 2.—Tibia of left side, anterior view.

Fig. 3.—View of the proximal articular faces of same.

Fig. 4.—Right femur, posterior view.

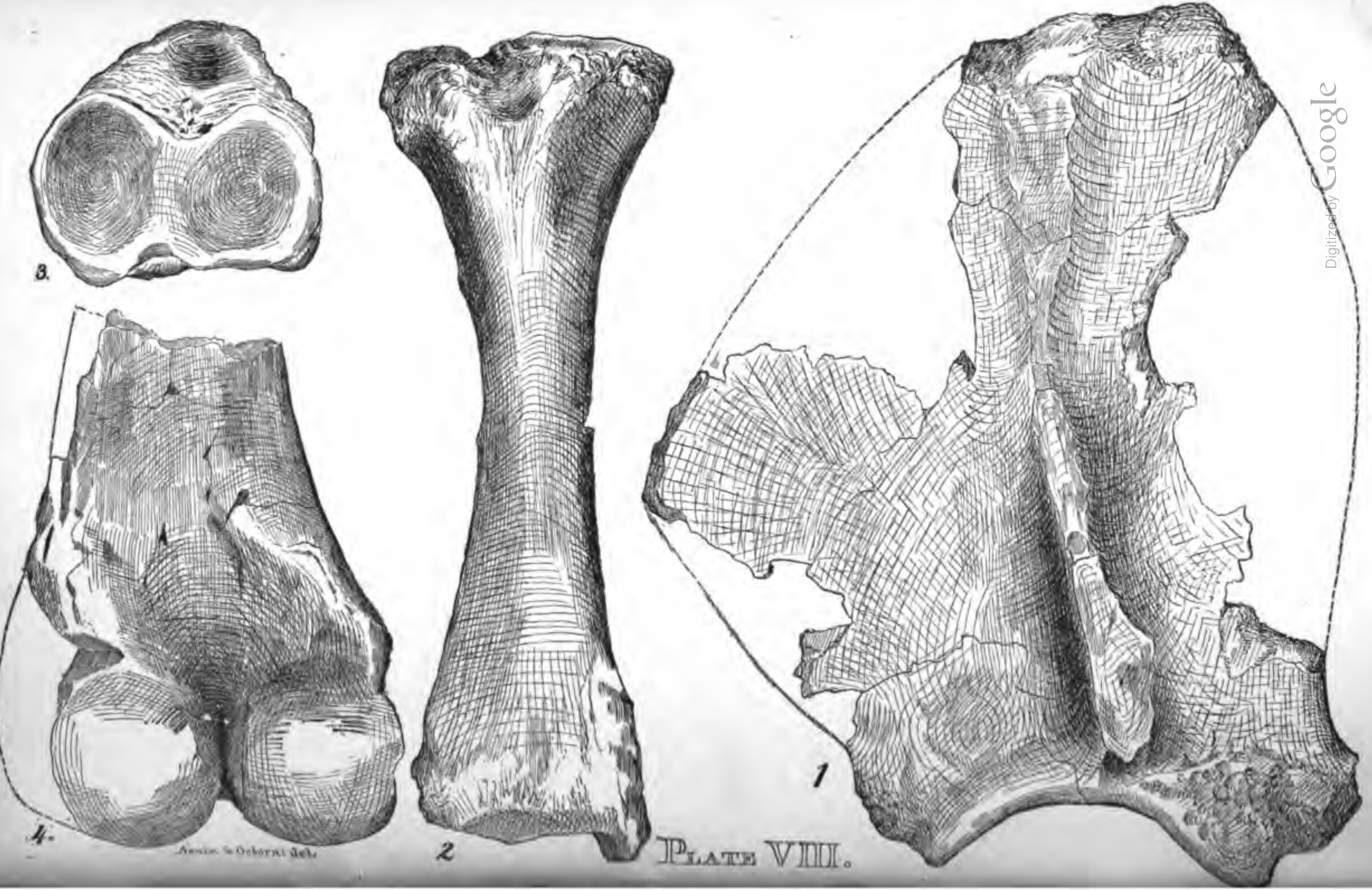


PLATE VIII.

EXPLANATION OF PLATE IX.

Figures four fifths natural size.

Orohippus major.

Fig. 1.—Right femur, anterior view, length estimated.

Fig. 2.—Right fibula.

Fig. 3.—Right tibia, anterior view.

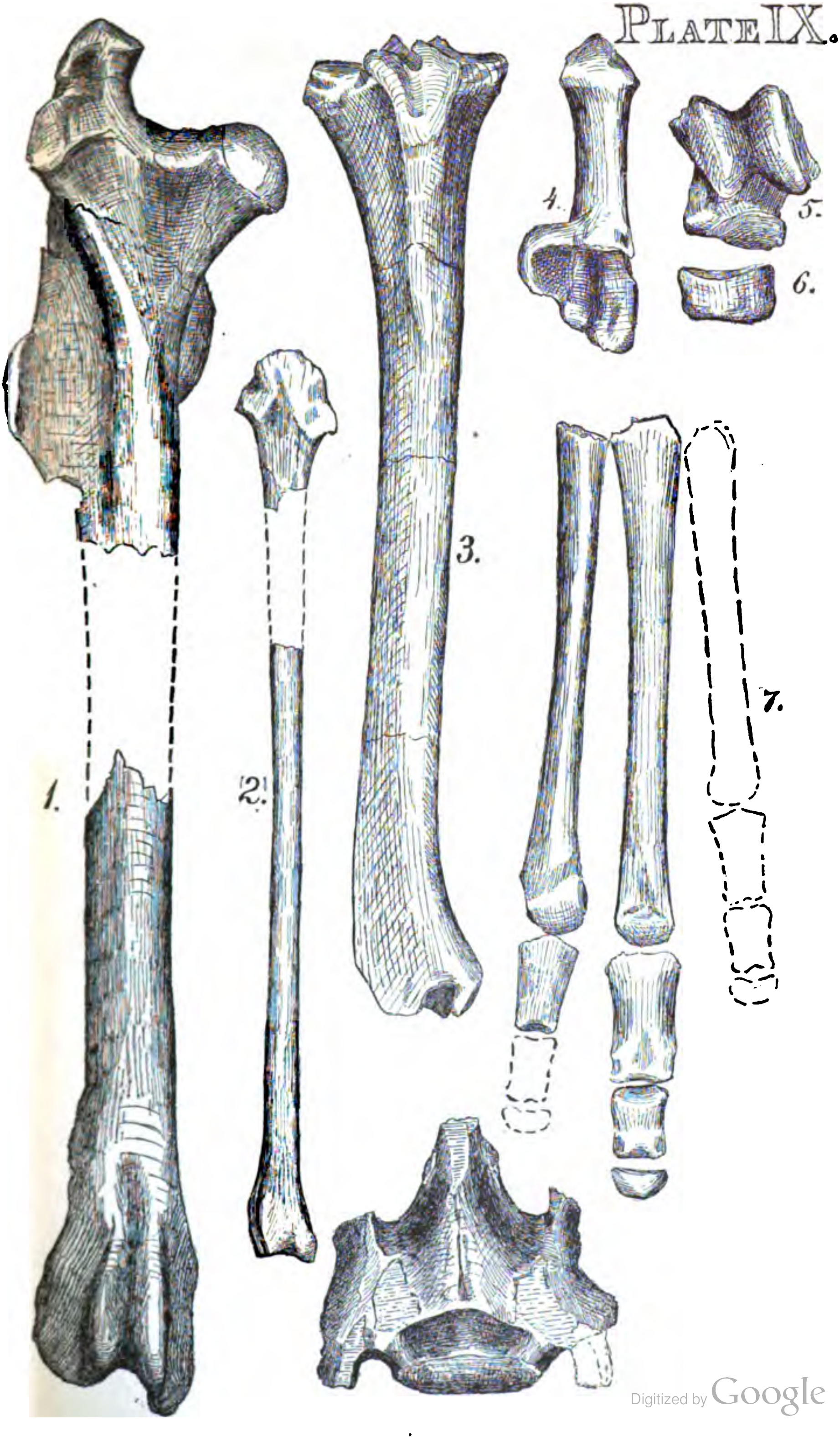
Fig. 4.—Calcaneum.

Figs. 5 and 6.—Astragalus and navicular.

Fig. 7.—Metatarsals and phalanges.

Last Fig.—A carnivorous sacrum, probably belonging to the brain, described on pp. 20–22.

PLATE IX.



EXPLANATION OF PLATE X.

Figures 1, 2, 3, 4, and 6, natural size.

ITHYGRAMMODON CAMELOIDES.

Fig. 1.—Left premaxillary, inner view.

Fig. 2.—Left premaxillary, outer view.

Fig. 3.—Right maxillary and premaxillary, outer view, premolar, with dotted outline indicating its probable position.

Fig. 4.—The premaxillaries in position (probable), view from above, showing size and position of the incisors. Dotted lines indicate the premaxillary spine (estimated).

PROCAMELUS OCCIDENTALIS, Cope. (See Wheeler's Survey, vol. iv., Plate LXXVII.)

Fig. 5.—Part of right maxillary and premaxillary, showing single incisor with rudimentary alveolus for a second.

PROTOLABIS ———? Cope. (See Wheeler's Survey, vol iv., p. 343.)

Fig. 6.—Right maxillary and premaxillary. (This has never been drawn before, and was kindly lent to us for this purpose by Prof. Cope.)

CAMELUS BACTRIANUS. Modern camel.

Fig. 7.—Right maxillaries, one half natural size.

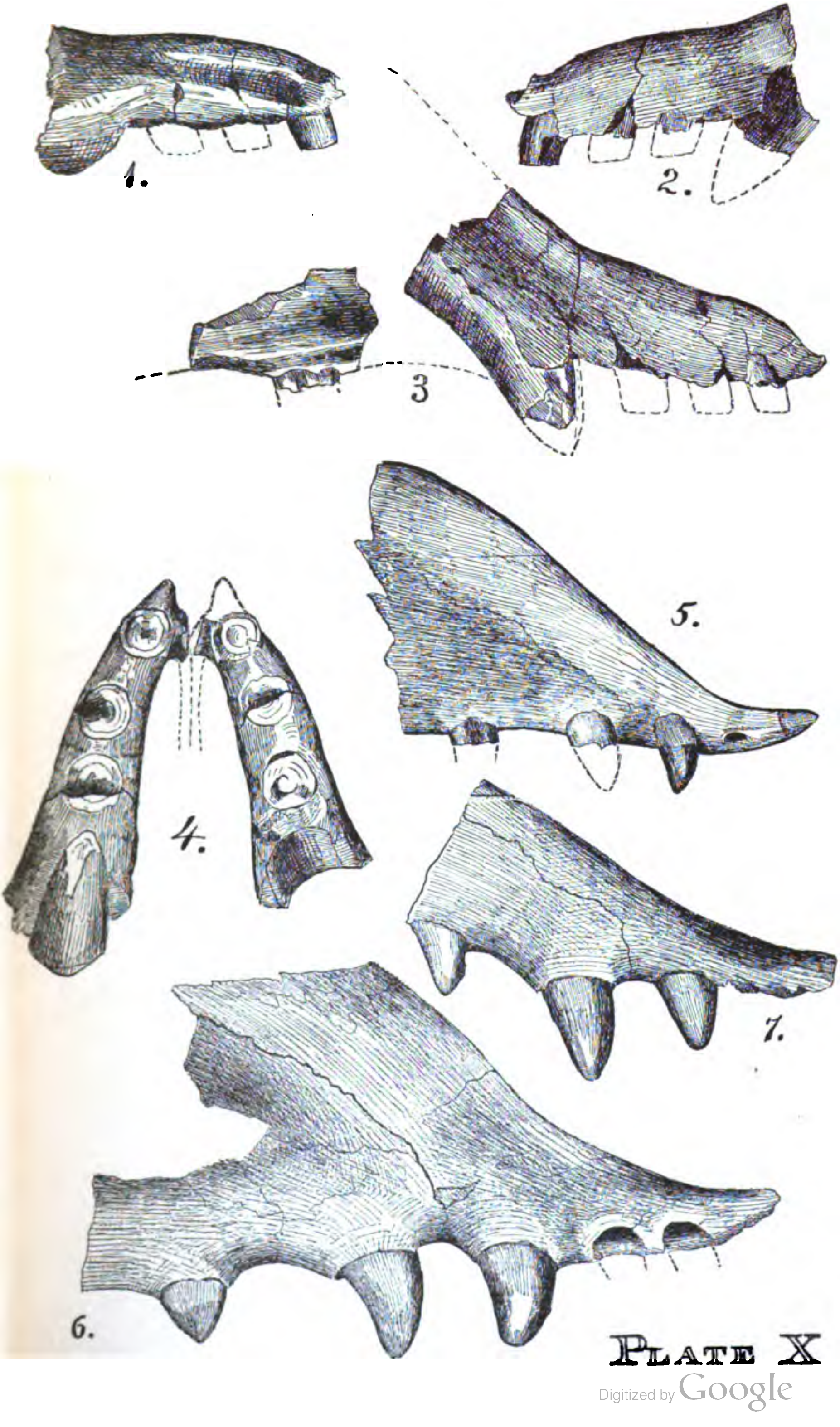


PLATE X

131

SYSTEMATIC CATALOGUE

OF THE

EOCENE VERTEBRATES OF WYOMING.

ALTHOUGH we have endeavored to make this catalogue as complete and accurate as possible, we feel that errors and omissions are, from the nature of the case, unavoidable. The material is so vast and heterogeneous, and is so much scattered throughout numberless reports, bulletins, journals, and the like, that its correct compilation is attended with great difficulties. However, a beginning is here made which will render subsequent work easier. Owing to the great number of discoveries which have since been made, Dr. Leidy's excellent catalogue of 1871 covers now but a very small portion of the ground.

In this list we have made no attempt to decide disputed questions of priority and synonymy. Doubtless, many of the genera and species here given will be found to be synonyms of American or European forms; but at present these questions cannot be settled. Where synonyms are given, they are the determinations of the original describer indicated in subsequent publications

MAMMALIA.

PRIMATES.

NOTHARCTUS, Leidy. Pr. Ac. Nat. Sc., 1870, p. 114; Cont. to Ext. Vert. Faun., p. 86; Ann. Rep. U. S. Geol. Survey of Terrs., 1871, p. 364.

N. tenebrosus, Leidy, loc. cit.

HYPSODUS, Leidy. Pr. Ac. Nat. Sc., 1870, p. 110; U. S. Survey of Terrs., 1870, p. 354; do. 1871, p. 362; Cont. to Ext. Vert. Faun., p. 75.

H. paulus, Leidy, loc. cit.
H. minusculus, Leidy. Cont. to Ext. Vert. Faun., p. 81.
H. gracilis, Marsh. Am. Journ. of Sci., vol. ii., p. 42.
H. vicarius, Cope. Described in U. S. Survey of Terrs., 1872, p. 609, as *Microsyops vicarius*. Wheeler's Survey, vol. iv., pt. ii., p. 150.

MICROSYOPS, Leidy. Pr. Ac. Nat. Sc., 1872, p. 20; U. S. Survey of Terrs., 1871, p. 363; Cont. to Ext. Vert. Faun., p. 82.

M. gracilis, Leidy, loc. cit. In the "Contributions," Dr. Leidy, considering *Limnotherium*, Marsh, as a synonym of *Microsyops*, has called this species *M. elegans*.

HIPPOSYUS, Leidy. Pr. Ac. Nat. Sc., 1872, p. 37; Cont. to Ext. Vert. Faun., p. 90.

H. formosus, Leidy, loc. cit.
H. robustior, Leidy. Cont. to Ext. Vert. Faun., p. 93; *Notharctus robustior*. U. S. Geol. Survey of Terrs., 1871, p. 364.

ANTIACODON, Marsh. Am. Journ. of Sci., 3d Ser. vol. iv., p. 210.

A. venustus, Marsh, loc. cit.

BATHRODON, Marsh. Am. Journ. of Sci., 3d Ser. vol. iv., p. 211.

B. typus, Marsh, loc. cit.

LEMURAVUS, Marsh. Am. Journ. of Sci., 3d Ser. vol. ix., p. 239.

L. distans, Marsh, loc. cit.

LIMNOTHERIUM, Marsh. Am. Journ. of Sci., 3d Ser. vol. ii., p. 43.

L. tyrannus, Marsh, loc. cit.
L. elegans, Marsh, loc. cit.
L. affine, Marsh. Am. Journ. of Sci., 3d Ser. vol. iv., p. 207.

MESACODON, Marsh. Am. Journ. of Sci., 3d Ser. vol. iv., p. 212.

M. speciosus, Marsh, loc. cit.

PALÆACODON, Leidy. Pr. Ac. Nat. Sc., 1872; p. 21 U. S. Geol. Survey of Terrs., 1871, p. 356; Cont. to Ext. Vert. Faun., p. 122.

P. verus, Leidy, loc. cit.
P. vagus, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 224.

TELMATOLESTES, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 206.

T. crassus, Marsh, loc. cit.

TOMITHERIUM, Cope. Pr. Am. Phil. Soc., 1872, p. 470; U. S. Geol. Survey of Terrs., 1872, p. 546; Wheeler's Survey, vol. iv., p. 135, pt. ii.

T. rostratum, Cope, loc. cit.; U. S. Survey, 1872, p. 548.

ANAPTOMORPHUS, Cope. Pr. Am. Phil. Soc., 1872, p. 554; U. S. Geol. Survey of Terrs., 1872, p. 549.

A. æmulus, Cope, loc. cit.

Oligotomus, Cope. On some Eocene mammals, p. 2; U. S. Geol. Survey of Terrs., 1872, p. 607.

O. cinctus, Cope, loc. cit.

Opisthotomus, Cope. Wheeler's Survey, vol. iv., p. 151, pt. ii.

O. astutus loc. cit., p. 152.

Pantolestes, Cope. Pr. Am. Phil. Soc., 1872, p. 467; Wheeler's Survey, v. iv., pt. ii., p. 145.

P. longicaudus, Pr. Am. Phil. Soc., 1872, p. 467; *Notharctus longicaudus*, U. S. Geol. Survey of Terrs., 1872, p. 549.

Sarcolemur, Cope. Pr. Ac. Nat. Sc., 1875, p. 256; Wheeler's Survey, v. iv., pt. ii., p. 147.

S. pygmæus, Cope. *Lophiotherium pygmæus*, Pr. Am. Phil. Soc., 1872, *extras* July 20; *Antiacodon pygmæus*, U. S. Geol. Survey of Terrs., 1872, p. 607; *Hyopsodus pygmæus*, Pr. Am. Phil. Soc., 1872, p. 461.

S. furcatus, Cope. *Antiacodon furcatus*, On some Eocene mammals, p. i.; U. S. Geol. Survey of Terrs., 1872, p. 608.

Thinolestes, Marsh. Am. Journ. Sc., 3d Ser. vol. iv., p. 205.

T. anceps, Marsh, loc. cit.

CARNIVORA.

Uintacyon, Leidy. Pr. Ac. Nat. Sc., 1872, p. 277; Cont. to Ext. Vert. Faun., p. 118.

U. edax, Leidy, loc. cit.
U. vorax, Leidy, loc. cit. Cont. to Ext. Vert. Faun., p. 120.

Sinopa, Leidy. Pr. Ac. Nat. Sc., 1871, p. 115; U. S. Geol. Survey of Terrs., 1871, p. 355; Cont. to Ext. Vert. Faun., p. 116.

S. rapax, Leidy, loc. cit.
S. eximia, Leidy. Cont. to Ext. Vert. Faun., p. 118.

Canis.

C. montanus, Marsh. Am. Journ. of Sc., 3d Ser. vol. ii., p. 123.

Dromocyon, Marsh. Am. Journ. of Sc., 3d Ser. vol. xii., p. 403.

D. vorax, Marsh, loc. cit.

Harpalodon, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 216.

H. sylvestris, Marsh, loc. cit.
H. vulpinus, Marsh, loc. cit., p. 217.

Limnocyon, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 126.

L. verus, Marsh, loc. cit.
L. riparius, Marsh, loc. cit, p. 203.
L. agilis, Marsh, loc. cit., p. 204.

Limnofelis, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 202.

L. ferox, Marsh, loc. cit.
L. latidens, Marsh, loc. cit., p. 203.

Oreocyon, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 406

O. latidens, Marsh, loc. cit.

Thinocyon, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 204.

T. velox, Marsh, loc. cit.

Viverravus, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 127.

V. gracilis, Marsh, loc. cit.
V. (?) *nitidus*, Marsh, loc. cit., p. 205.

Ziphacodon, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 216.

Z. rugatus, Marsh, loc. cit.

Vulpavus, Marsh. Am. Journ. of Sc., 3d Ser. vol. ii., p. 124.

V. palustris, Marsh, loc. cit.

Miacis, Cope. Pr. Am. Phil. Soc., 1872, p. 470.

M. parvivorus, loc. cit.; *Viveravus parvivorus*, U. S. Geol. Survey of Terrs., 1872, p. 560.

Mesonyx, Cope. Pr. Am. Phil. Soc., 1872. p. 460; U S. Geol. Survey of Terrs., 1872, p. 550.

M. obtusidens, Cope, loc. cit. U. S. Survey, p. 552.

Synoplotherium, Cope. Pr. Am. Phil. Soc., 1872, p. 483; U. S. Geol. Survey of Terrs., 1872, p. 554.

S. lanius, Cope, loc. cit. U. S. Survey, p. 557.

Stypolophus, Cope. Pr. Am. Phil. Soc., 1872, p. 466; U. S. Geol. Survey of Terrs., 1872, p. 559; Wheeler's Survey, vol. iv., p. 109.

S. insectivorus, Cope. Pr. Phil. Soc., 1872, p. 469; U. S. Survey, 1872, p. 557.
S. pungens, Cope, loc. cit., pp. 466, 559.
S. brevicalcaratus, Cope, loc. cit., pp. 469, 560.

Megencephalon, gen. nov. This report, p. 20.

M. primævus, sp. nov. This report, p. 20.

UNGULATA.

PERISSODACTYLA.

Anchitherium.

A. (?)————. This report, p. 23.

Orohippus, Marsh. Am. Journ. of Sc., vol. iv., p. 207; vol. vii., p. 247.

O. pumilus, Marsh, loc. cit., 3d Ser. vol. iv., p. 207.
O. agilis, Marsh, loc. cit., 3d Ser. vol. v., p. 407.
O. major, Marsh, loc. cit., vol. 3d Ser. vii., p. 248.
O. gracilis, Marsh, loc. cit., 3d Ser. vol. vii., p. 249; *Anchitherium gracile*, 3d Ser. vol. ii., p. 38.
O. procyoninus, Cope. Pr. Am. Phil. Soc., 1872, p. 466; U. S. Survey, 1872, p. 606.

PALÆOSYOPS, Leidy. Pr. Ac. Nat. Sc., 1870, p. 113; 1871, pp. 114, 118, 197, 229; 1872, pp. 168, 241; U. S. Geol. Survey, 1870, p. 355; 1871, p, 358; Cont. to Ext. Vert. Faun., p. 27; Cope, U. S. Geol, Survey of Terrs., 1872, p. 591.

P. paludosus, Leidy, loc. cit. Cont. to Ext. Vert. Faun., p. 28.

P. major, Leidy. U. S. Geol. Survey of Montana, 1871, p. 359; Pr. Ac. Nat. Sc., 1872, pp. 168, 241; Cont. to Ext. Vert. Faun., p. 45.

P. humilis, Leidy. Pr. Ac. Nat. Sc., 1872, p. 168, 277; Cont. to Ext. Vert. Faun., p. 58.

P. junius, Leidy. Pr Ac. Nat. Sc., 1872, p. 277; Cont. to Ext. Vert. Faun., p. 57.

P. lævidens, Cope. Pr. Am. Phil. Soc., 1873; U. S. Survey, 1872, p. 591.

P. vallidens, Cope. Pr. Am. Phil. Soc., 1872, p. 487; loc. cit., p. 592.

P. minor, Marsh. Am. Journ. of Sc., vol. ii., p. 36.

LIMNOHYUS, Leidy. Pr. Ac. Nat. Sc., 1872, p. 242; Cont. to Ext. Vert. Faun., p. 58; Marsh, Am. Journ. of Sc., 1872, 3d Ser. vol. iv., p. 124.

L. laticeps, Marsh. *Palæosyops laticeps*. Am. Journ. Sc. 3d Ser. vol. iv., p. 122.

L. robustus, Marsh, loc. cit., p. 124, is same as *P. major*, Leidy.

L. diaconus, Cope. U. S. Geol. Survey of Terrs., 1872, p. 593.

L. fontinalis, Cope, loc. cit., 594.

TELMATHERIUM, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 123.

T. validum, Marsh, loc. cit.

LEUROCEPHALUS, gen. nov. This report, p. 42.

L. cultridens, sp. nov. This report, p. 42.

HYRACHYUS, Leidy. Pr. Ac. Nat. Sc., 1871, p. 229; 1872, pp. 19, 163; U. S. Geol. Survey, 1871, p. 360; Cont. to Ext. Vert. Faun., p. 60.

H. agrarius, Leidy, loc. cit.; *H. agrestis*, U. S. Survey, 1871, p. 357.

H. eximius, Leidy. Pr. Ac. Nat. Sc., 1871 p. 229; 1872, p. 163; U. S. Geol. Survey of Terrs., 1871, p. 361; Cont. to Ext. Vert. Faun., p. 66; Cope, U. S. Geol. Survey of Terrs., 1872, p. 595.

H. modestus, Leidy. Pr. Ac. Nat. Sc., 1872, p. 20; U. S. Geol. Survey of Terrs., 1871, p. 361; Cont. to Ext. Vert. Faun., p. 67; *Lophiodon modestus*, Pr. Ac. Nat. Sc., 1870, p. 109.

H. nanus, Leidy. Pr. Ac. Nat. Sc., 3d Ser. 1872, p. 20; U. S. Survey, 1871, p. 361; Cont. to Ext. Vert. Faun., p. 67.

H. princeps, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 125.

H. implicatus, Cope. On Some Eocene Mammals, p. 5; U. S. Survey, 1872, p 604.

H. crassidens, sp. nov. This report, p. 52.

H. imperialis, sp. nov. This report, p. 50.

H. intermedius, sp. nov. This report, p. 51.

H. paradoxus, sp. nov. This report, p. 53.

HELALETES, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 218.

H. boöps, Marsh, loc. cit.

H. latidens, *sp. nov.* This report, p. 54.

LOPHIODON.

L. bairdianus, Marsh. Am. Journ. of Sc., 3d Ser. vol. ii., p. 36.
L. affinis, loc. cit., p. 37.
L. nanus, loc. cit.
L. pumilus, loc. cit., p. 38.

LOPHIOTHERIUM.

L. sylvaticum, Leidy. Pr. Ac. Nat. Sc., 1870, p. 126; Cont. to Ext. Vert., Fann, p. 69.
L. Ballardi, Marsh. Am. Journ. of Sc., 3d Ser. vol. ii., p. 39.

OROTHERIUM, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 217.
O. uintanum, Marsh, loc. cit.

HELOHYUS, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 207.
H. plicodon, Marsh, loc. cit.

THINOTHERIUM, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 208.
T. validum, Marsh, loc. cit.

ARTIODACTYLA.

All the forms described under this head are of uncertain reference.

ELOTHERIUM.

E. lentum, Marsh. Am. Journ. of Sc., 3d Ser. vol. ii., p. 39.

PLATYGONUS.

P. Zieglcri, Marsh, loc. cit., p. 40.

PARAHYUS, Marsh. Am. Journ. of Sc., 3d Ser. vol. xii., 402.
P. vagus, Marsh, loc. cit.

HOMACODON, Marsh. Am. Jour. of Sc., 3d Ser. vol. iv., p. 126.
H. vagans, Marsh, loc. cit.

ITHYGRAMMODON, gen. nov. This report, p. 56.
I. cameloides, sp. nov. This report, p. 57.

AMBLYPODA.

Cope. Wheeler's Survey, vol., iv., pt. ii., p. 179.

DINOCERATA.

Marsh. Am. Jour. of Sc., 3d Ser. vol. iv., p. 344; Ibid. vol. v., pp. 117–122, 293; Ibid. vol. vi., p. 300; Ibid. vol. xi., p. 163.

UINTATHERIUM, Leidy. Pr. Ac. Nat. Sc., 1872, p. 169; Am. Joun. of Sc., 3d Ser. vol. iv., p. 239; Cont. to Ext. Vert. Faun., p. 96.
U. robustum, Leidy, loc. cit.; *Uintamastix atrox*, loc. cit.
U. Leidianum, sp. nov. This report, p. 3.
U. princeps, sp. nov. This report, p. 81.

TINOCERAS, Marsh. *Titanotherium* (?), Am. Journ. of Sc., 3d Ser. vol. ii., p. 35; *Mastodon*, loc. cit., vol. iv., p. 123, footnote; *Tinoceras*, loc. cit., vol. iv., pp. 322 and 323.

T. anceps, Marsh, loc. cit.; vol. iv., p. 322.
T. grandis, Marsh, loc. cit., p. 323.

DINOCERAS, Marsh. Am. Jour. of Sc., 3d Ser. vol. iv., p. 344; Ibid. vol. v., pp. 117–122; Ibid. vol. v., p. 408.

D. mirabilis, Marsh, loc. cit., vol. iv., p. 344.
D. lucaris, Marsh, loc. cit., vol. v., p. 408.
D. lacustre, Marsh, loc. cit., vol. iv., p. 344.

LOXOLOPHODON, Cope. Pr. Am. Phil. Soc., 1872, pp. 580, 488; U. S. Survey, 1872, p. 565.

L. cornutus, Cope, loc. cit.; U. S. Survey, 1872, p. 568.

EOBASILEUS, Cope. Pr. Am. Phil. Soc., 1872, p. 485; U. S. Survey, 1872, p. 575.

E. pressicornis, Cope. Pr. Am. Phil. Soc., 1872, p. 580; loc. cit.

E. furcatus, Cope. U. S. Survey, 1872, p. 580; *Loxolophodon furcatus*, Pr. Am. Phil. Soc., 1872, p. 580.

CORYPHODON.

C. hamatus, Marsh. Am. Journ. of Sc., 3d Ser. vol. xi., p. 425.

BATHMODON, Cope. Pr. Am. Phil. Soc., 1872, p. 417; U. S. Geol. Survey, 1871, p. 350; 1872, p. 586.

B. radians, Cope, loc. cit.
B. semicinctus, Cope, loc. cit.
B. latipes, Cope, loc. cit.

METALOPHODON, Cope. Pr. Am. Phil. Soc., 1872, p. 542; U. S. Geol. Survey, 1872, p. 589.

M. armatus, Cope, loc. cit.

TILLODONTIA.

Marsh. Am. Jour. of Sc., 3d Ser. vol. ix., p. 221; vol. xi., p. 249.

ANCHIPPODUS, Leidy. Pr. Ac. Nat. Soc., 1868, p. 232; Ext. Mam. N. Am., p. 403.

Trogosus. Pr. Ac., 1871, p. 113; Cont. to Ext. Vert. Faun., p. 71.

A. riparius, Leidy. Pr. Ac. Nat. Soc., 1868, p. 232; Cont. to Ext. Vert. Faun., p. 71 (as *Trogosus castoridens*).

A. vetulus, Leidy; *Trogosus vetulus*, Pr. Ac. Nat. Sc., 1871, p. 229; Cont. to Ext. Vert. Faun., p. 75.

TILLOTHERIUM. Am. Jour. of Sc., 3d Ser. vol. v., p. 485; Ibid. vol. xi., p. 249.

T. hydracoides, Marsh, loc. cit.
T. latidens, Marsh, loc. cit., vol. vii., p. 533.
T. fodiens, Marsh, loc. cit., vol. ix., p. 241.

STYLINODON, Marsh. Am. Jour. of Sc., 3d Ser. vol. vii., p. 532.

S. mirus, loc. cit.

RODENTIA.

PARAMYS, Leidy. Pr. Ac. Nat. Sc., 1871, p. 231; U. S. Geol. Survey, 1871, p. 357; Cont. to Ext. Vert. Faun., p. 110.

- *P. delicatus*, Leidy, loc. cit.
- *P. delicatior*, Leidy, loc. cit.
- *P. delicatissimus*, Leidy, loc. cit.; Cont. to Ext. Vert. Faun., p. 111.
- *P. robustus*, Marsh. Am. Jour. of Sc., 3d Ser. vol. iv., p. 218,
- *P. superbus*, sp. nov. This report, p. 84.
- *P. leptodus*, Cope. U. S. Geol. Survey, 1872, p. 609.

MYSOPS, Leidy. Pr. Ac. Nat. Sc., 1871, p. 232; U. S. Geol. Survey, 1871, p. 357; Con.t to Ext. Vert. Faun., p. 111.

- *M. minimus*, Leidy, loc. cit.
- *M. fraternus*, Leidy. Cont. to Ext. Vert. Faun., p. 112.

PSEUDOTOMUS, Cope. Pr. Am. Phil. Soc., 1872, p. 467; U. S. Geol. Survey, 1872, p. 610.

- *P. hians*, Cope, loc. cit.

ARCTOMYS, Marsh. Am. Jour. of Sc., 3d Ser. vol. ii., p. 121.

- *A. vetus*, Marsh, loc. cit.

GEOMYS, Marsh. Am. Jour. of Sc., 3d Ser. vol. ii., p. 121.

- *G. bisulcatus*, Marsh, loc. cit.

SCIURAVUS, Marsh. Am. Jour. of Sc., 3d Ser. vol. ii., p. 122.

- *S. nitidus*, Marsh, loc. cit.
- *S. undans*, Marsh, loc. cit.
- *S. parvidens*, Marsh, loc. cit., 3d Ser. vol. iv., p. 220.

TILLOMYS, Marsh. Am. Jour. of Sc., 3d Ser. vol. iv., p. 219.

- *T. senex*, Marsh, loc. cit.
- *T. parvus*, Marsh, loc. cit.

TACHYMYS, Marsh. Am. Jour. of Sc., 3d Ser. vol. iv., p. 219.

- *T. lucaris*, Marsh, loc. cit.

COLONYMYS, Marsh. Am. Jour. of Sc., 3d Ser. vol. iv., p. 220.

- *C. celer*, Marsh, loc. cit.

INSECTIVORA.

OMOMYS, Leidy. Pr. Ac. Nat. Sc., 1869, p. 63; Ext. Mam. of N. Am., p. 408; Cont. to Ext. Vert. Faun., p. 120.

- *O. Carteri*, Leidy, loc. cit.

WASHAKIUS, Leidy. Cont. to. Ext. Vert. Faun., p. 123.

- *W. insignis*, Leidy, loc. cit.

PASSALACODON, Marsh. Am. Jour. of Sc., vol. iv. p. 208.

- *P. litoralis*, Marsh, loc. cit.

ANISACODON,* Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 209.
A. elegans, Marsh, loc. cit.

CENTETODON, Marsh, Am. Journ. of Sc., 3d Ser. vol. iv., p. 209.
C. pulcher, Marsh, loc. cit.
C. altidens, Marsh, loc. cit., p. 214.

HEMIACODON, Marsh, Am. Journ. of Sc., 3d Ser. vol. iv., p. 212.
H. gracilis, Marsh, loc. cit.
H. nanus, Marsh, loc. cit., p. 113.
H. pucillus, Marsh, loc. cit.

ENTOMODON, Marsh, Am. Journ. of Sc., 3d Ser. vol. iv., p. 214.
E. comptus, Marsh, loc. cit.

ENTOMACODON, Marsh, Am. Journ. of Sc., 3d Ser. vol. iv., p. 214.
E. minutus, Marsh, loc. cit.
E. angustidens, Marsh, loc. cit., p. 222.

APATEMYS, Marsh, Am. Journ. of Sc., 3d Ser. vol. iv., p. 221.
A. bellus, Marsh, loc. cit.
A. bellulus, Marsh, loc. cit.

TALPAVUS, Marsh, Am. Journ. of Sc., 3d Ser. vol. iv., p. 128.
T. nitidus, Marsh, loc. cit.

CHIROPTERA.

NYCTITHERIUM, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 127.
N. velox, Marsh, loc. cit.
N. priscum, Marsh, loc. cit., p. 128.

NYCTILESTES, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 215.
N. serotinus, Marsh, loc. cit.

MARSUPIALIA.

TRIACODON, Marsh. Am. Journ. of Sc., 3d Ser. vol. ii., p. 123.
T. fallax, Marsh, loc. cit.
T. grandis, Marsh, loc. cit. 3d Ser. vol. iv., p. 222.
T. nanus, Marsh, loc. cit., p. 223.
T. aculeatus, Cope. Pr. Phil. Soc., 1872, p. 460; U. S. Geol. of Terrs., 1872, p. 611.

Genera incertæ sedis.

STENACODON, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 210.
S. rarus, Marsh, loc. cit.

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* Professor Marsh has subsequently used this name to designate a genus of the *Brontotheridæ*. Am. Jour. of Sc., vol. ix., p. 246.

AVES.

RAPTORES.

Bubo.

B. leptosteus, Marsh. Am. Journ. of Sc., 3d Ser. vol. ii, p. 126.

GRALLATORES.

Aletornis, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 256.

A. nobilis, Marsh, loc. cit.
A. pernix, Marsh, loc. cit.
A. venustus, Marsh, loc. cit., p. 257.
A. gracilis, Marsh, loc. cit., p. 258.
A. bellus, Marsh, loc. cit.

SCANSORES.

Uintornis, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 259.

U. lucaris, Marsh, loc. cit.

REPTILIA.

CROCODILIA.

Crocodilus.

C. liodon, Marsh. Am. Journ. of Sc., 3d Ser. vol. i., p. 454.
C. affinis, Marsh, loc. cit.
C. Grinnellii, Marsh, loc. cit., p. 455.
C. brevicollis, Marsh, loc. cit., p. 456.
C. parvus, sp. nov. This report, p. 91.
C. clavis, Cope. Pr. Am. Phil. Soc., 1872, p. 485; U. S. Geol. Survey, 1872, p. 612.
C. sulciferus, Cope. Pr. Am. Phil. Soc., 1872, p. 555; U. S. Survey, loc. cit.
C. hetorodon, Cope. *Alligator heterodon*, Pr Am. Phil. Soc., 1872, p. 544; U. S. Geol. Survey, 1872, p. 614.
C. aptus, Leidy. Cont. to Ext. Vert. Faun., p. 126.
C. Elliotii, Leidy, loc. cit.

Diplocynodus.

D. subulatus, Cope. U. S. Geol. Survey, 1872, p. 613; *Crocodilus subulatus*, Pr. Am. Phil. Soc., 1872, p. 554.

D. polyodon, Cope. U. S. Geol. Survey, 1872, p. 614. (In his report to Lt. Wheeler, Prof. Cope says that "a single species, the *D. subulatus*, occurs" in the Bridger Basin, (p. 60). It is therefore probable that he has changed the *D. polyodon*, but we cannot find its synonym.)

LACERTILIA.

SANIVA, Leidy. Pr. Ac. Nat. Sc., 1870, p. 124; U. S. Survey, 1870, p. 368; do., 1871, p. 370; Cont. to Ext. Vert. Faun., p. 181.

S. ensidens, Leidy, loc. cit.
S. major, Leidy. Cont. to Ext. Vert. Faun., p. 182.

CHAMELEO.

C. pristinus, Leidy. Pr. Ac. Nat. Sc., 1872, p. 277; Cont. to Ext. Vert. Faun., p. 184.

NAOCEPHALUS, Cope. Pr. Am. Phil. Soc., 1872, p. 465; U. S. Geol. Survey, 1872, p. 631.

N. porrectus, Cope, loc. cit.; U. S. Geol. Survey, 1872, p. 632.

GLYPTOSAURUS, Marsh. Pr. Ac. Nat. Sc., 1871, p. 105; Am. Journ. of Sc., 3d Ser. vol. i., p. 456.

G. sylvestris, Marsh, loc. cit.
G. nodosus, Marsh, Am. Journ. of Sc., vol. i., p. 458.
G. ocellatus, Marsh, loc. cit., vol. i., p. 458, and vol. iv., p. 306.
G. anceps, Marsh, loc. cit., vol. i., p. 458.
G. princeps, Marsh, loc. cit., 3d Ser. vol. iv., p. 302.
G. brevidens, Marsh, loc. cit., p. 305.
G. rugosus, Marsh, loc. cit.
G. sphenodon, Marsh, loc. cit., p. 306.

THINOSAURUS, Marsh. Am. Journ. of Sc., 3 Ser. vol. iv., p. 299.

T. paucidens, Marsh, loc. cit.
T. leptodus, Marsh, loc. cit., p. 300.
T. crassus, Marsh, loc. cit., p. 301.
T. grandis, Marsh, loc. cit.
T. agilis, Marsh, loc. cit., p. 302.

OREOSAURUS, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 303.

O. vagans, Marsh, loc. cit.
O. lentus, Marsh, loc. cit., p. 307.
O. gracilis, Marsh, loc. cit.
O. microdus, Marsh, loc. cit., p. 308.
O. minutus, Marsh, loc. cit.

TINOSAURUS, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 304.

T. stenodon, Marsh, loc. cit.
T. lepidus, Marsh, loc. cit., p. 308.

IGUANAVUS, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 309.

I. exilis, Marsh, loc. cit.

LIMNOSAURUS, Marsh. Am. Journ. of Sc., 3d Ser. vol. iv., p. 309.

L. ziphodon, Marsh, loc. cit.; *Crocodilus ziphodon*, loc. cit., vol. i., p. 453.

OPHIDIA.

BOAVUS, Marsh. Am. Journ. of Sc., 3d Ser. vol. i., p. 323.

B. occidentalis, Marsh, loc. cit.
B. agilis, Marsh, loc. cit., p. 324.
B. brevis, Marsh, loc. cit.

LITHOPHIS, Marsh. Am. Journ. of Sc., 3d Ser. vol. i., p. 325.

L. Sargenti, Marsh, loc. cit.

LIMNOPHIS, Marsh. Am. Journ. of Sc, 3d Ser. vol. i., p. 326.

L. crassus, Marsh, loc. cit.

PROTAGRAS, Cope. Pr. Am. Phil. Soc., 1872, p. 471 : U. S. Geol.Survey, 1872, p. 632.

P. lacustris, Cope, loc. cit.

CHELONIA.

TESTUDO.

T. Corsoni, Leidy. Pr. Ac. Nat. Sc., 1871, p. 154 ; 1872, p. 268 ; U. S. Geol. Survey, 1871, p. 366 ; Cont. to Ext. Vert. Faun., p. 132 ; *Emys Carteri*, Pr. Ac. Nat. Sc., 1871, p. 228 ; U. S. Geol. Survey, 1871, p. 367. (Professor Cope refers this species to his *Hadrianus*.)

HADRIANUS, Cope. Pr. Am. Phil. Soc., 1872, p. 468 ; U. S. Geol. Survey of Terrs.,1872, p. 630.

H. allabiatus, Cope. Pr. Am. Phil. Soc., 1872, p. 471 ; U. S. Survey, loc. cit.
H. octonarius, Cope, loc, cit. Pr. Am. Phil. Soc. 1872, p. 468.

EMYS.

E. wyomingensis, Leidy. Pr. Ac. Nat. Sc., 1869, p. 66 ; U. S. Geol. Survey, 1871, p. 367 ; Cont. to Ext. Vert. Faun., p. 140. *E. Jeansii*, Pr. Ac. Nat. Sc., 1870, p. 123 ; *E. stevensoniansis*, loc. cit., p. 5. *E. Haydeni*, loc. cit., p. 123.

E. septarius, Cope. U. S. Geol. Survey, 1872, p. 625.

E. latilabiatus, Cope. Pr. Am. Phil. Soc., 1872, p. 471 ; loc. cit., p. 626.

E. gravis, Cope. *Notomorpha gravis* and *N. Garmanii*, Pr. Am. Phil. Soc., 1872, pp. 476–77 ; *E. gravis*, U. S. Survey, 1872, p. 626.

E. testudineus, Cope. U. S. Geol. Survey, 1872, p. 627 ; *Notomorpha testudineus*, Pr. Am. Phil. Soc., 1872, p. 475.

E. euthnætus, Cope. U. S. Geol. Survey, 1872, p. 628.

E. megaulax, Cope, loc. cit.

E. pachylomus, Cope, loc. cit., p. 629.

E. terrestris, Cope, loc. cit. ; *Palæotheca terrestris*, Pr. Am. Phil. Soc., 1872, p. 464.

E. polycyphus, Cope, loc. cit., 630 ; *P. polycyphus*, loc. cit., p. 463.

HYBEMYS, Leidy. Pr. Ac. Nat. Sc., 1871 ; p. 103 ; Cont. to Ext. Vert. Faun., p. 174.

H. arenarius, Leidy, loc. cit.

BAPTEMYS, Leidy. Pr. Ac. Nat. Sc., 1870, p. 4; U. S. Survey, 1870, p. 367; do., 1872, p. 367; Cont. to Ext. Vert. Faun., 157. (Professor Cope refers this genus to *Dermatemys Gray*).

B. wyomingensis, Leidy, loc. cit.

CHISTERNON, Leidy. Pr. Ac. Nat. Sc., 1872, p. 162.

C. undatum. Cont. to Ext. Vert. Faun., p. 341; *Baena undata*, Pr. Ac. Nat. Sc., 1871, p. 228; U. S. Survey, 1871, p. 369; Cont. to Ext. Vert. Faun., p. 161.

BAENA, Leidy. Pr. Ac. Nat. Sc., 1871, p. 228; U. S. Survey, 1870, p. 367; do., 1871, p. 368; Cont. to Ext. Vert. Faun., p. 161.

B. arenosa, Leidy, loc. cit.; *Baena affinis*, U. S. Survey, 1870, p. 367.

B. hebraica, Cope. Pr. Am. Phil. Soc., 1872, p. 463; U. S. Survey, 1872, p. 621.

B. ponderosa, Cope. U. S. Survey, 1872, p. 624.

ANOSTEIRA, Leidy. Pr. Ac. Nat. Sc., 1871, p. 102, 114; U. S. Survey, 1871, p. 370; Cont. to Ext. Vert. Faun., p. 174.

A. ornata, Leidy, loc. cit.

A. radulina, Cope. Pr. Am. Phil. Soc., 1872, p. 555; U. S. Survey, 1872, p. 650.

TRIONYX.

T. guttatus, Leidy. Pr. Ac. Nat. Sc., 1869, p. 66; 1870, p. 5; 1871, p. 228; U. S Geol. Survey, 1870, p. 367; do., 1871. p. 370; Cont. to Ext. Vert. Faun., p. 176.

T. uintaensis, Leidy. Pr. Ac. Nat. Sc., 1872, p. 267; Cont. to Ext. Vert. Faun., p. 178.

T. heteroglyptus, Cope. U. S. Geol, Survey, 1872, p. 616.

T. scutumantiquum, Cope, loc. cit., p. 617.

T. concentricus, Cope, loc. cit.; Pr. Am. Phil. Soc., 1872, p. 469.

AXESTUS, Cope. Pr. Am. Phil. Sc., 1872, p. 462; U. S. Geol. Survey, 1872, p. 615.

A. byssinus, Cope, loc. cit., p. 616.

PLASTOMENUS, Cope. U. S. Geol. Survey of Terrs. 1872, p. 617.

P. Thomasii, Cope, loc. cit., p. 618; *Trionyx Thomasii*, Pr. Am. Phil. Soc., 1872, p. 462.

P. trionychoides, Cope, loc. cit., 619; *Anostira trionychoides*, Pr. Am. Phil. Soc., 1872, p. 461.

P. multifoveatus, Cope, loc. cit., p. 619.

P. œdemius, Cope, loc. cit.; *Anostira œdemius*, Pr. Am. Phil. Soc., 1872, p. 461.

P. molopinus, Cope, loc. cit. p. 620; *Anostira molopinus*, Pr. Am. Phil. Soc., 1872, p. 461.

AMPHIBIA.

Incertæ sedis, 1, Cope. U. S. Geol. Survey, 1872, p. 633.

PISCES.

TELEOCEPHALI.

CLUPEA.

C. humilis, Leidy. Pr. Ac. Nat. Sc., 1856, p. 266; U. S. Geol. Survey, 1870, p. 369; do., 1871, p. 372; Cont. to Ext. Vert. Faun., p. 195.

C. alta, Leidy. Cont. to Ext. Vert. Faun., p. 196. (Cope refers these two species to *Diplomystus*)

C. pusilla, Cope. Pr. Am. Phil. Soc., 1870, p. 382; U. S. Survey, 1870, p. 429.

DIPLOMYSTUS, Cope. U. S. Geol. Survey Bulletin, vol. iii., No. 4, p. 808.

D. dentatus, Cope, loc. cit.
D. analis, Cope, loc. cit., p. 809.
D. pectorosus, Cope, loc. cit., p. 810.

OSTEOGLOSSUM.

O. encaustum, Cope. U. S. Geol. Survey, 1870, p. 430.

DAPEDOGLOSSUS, Cope. U. S. Geol. Survey; Bulletin, vol. iii., No. 4, p. 807.

D. testis, Cope, loc. cit.
D. æquipinnis, Cope, loc. cit., vol. iv., No. 1, p. 77.

ERISMATOPTERUS, Cope. U. S. Geol. Survey, 1870, p. 427.

E. Ricksecker, Cope, loc. cit.

E. levatus, Cope, loc. cit., p. 428; *Cyprinodon levatus*, Pr. Am. Phil. Soc., 1870, p. 382.

E. Endlichi, Cope. U. S. Geol. Survey Bulletin, vol. iii., No. 4, p. 811.

AMPHIPLAGA, Cope. U. S. Geol Survey Bull., vol. iii., No. 4, p. 812.

A. brachyptera, Cope, loc. cit.

ASINEOPS, Cope. Pr. Am. Phil. Soc., 1870, p. 380; U. S. Geol. Survey, 1870, p. 425.

. *squamifrons*, Cope. Pr. Phil. Soc., p. 381; U. S. Survey, 1870, p. 426.
A. vividensis, Cope. U. S. Survey, 1870, p. 426.
A. pauciradiatus, Cope. U. S. Geol. Survey Bull., vol. iii., No. 4, p. 813.

MIOPLOSUS, Cope. U. S. Geol. Survey Bull., vol. iii., No. 4, p. 813.

M. abbreviatus, Cope, loc. cit.
M. labracoides, Cope, loc. cit., p. 814.
M. longus, Cope, loc. cit., p. 815.
M. Beanii, Cope, loc. cit., p. 816.

PRISCACARA, Cope. U. S. Geol. Survey Bull., vol. iii., No. 4, p. 816.

P. serrata, Cope, loc. cit.
P. cypha, Cope, loc. cit., p. 817.

P. liops, Cope, loc. cit., p. 818.
P. oxyprion, Cope, loc. cit., vol. iv., No. 1, p. 74.
P. Pealeii, Cope, loc. cit., p. 75.
P. clivosa, Cope, loc. cit., p. 76.

NEMATOGNATHI.

PIMELODUS.

P. ~~antiquus~~, Leidy. Pr. Ac. Nat. Sc., 1873, p. 99; Cont. to Ext. Vert. Faun., p. 193.

PHAREODON, Leidy. Pr. Ac. Nat. Sc., 1873, p. 99; Cont. to Ext. Vert. Faun., p. 193.

P. acutus, Leidy, loc. cit.
P. sericeus, Cope, U. S. Geol. Survey, 1872, p. 638.

RHINEASTES, Cope. Pr. Am. Phil. Soc., 1872, p. 486; U. S. Geol. Survey, 1872, p. 638.

R. peltatus, Cope, loc. cit.
R. Smithii, Cope, loc. cit.
R. radulus, Cope. U. S. Geol. Survey, 1872, p. 639.
R. calvus, Cope, loc. cit., p. 640.
R. arcuatus, Cope, loc. cit., p. 641.

CYCLOGANOIDEI.

AMIA. *A.* (*Protamia*) *uintaensis*, Leidy. Pr. Ac. Nat. Sc., 1873, p. 98; Cont., p. 185.

A. (*Protamia*) *media*, Leidy, loc. cit.; Cont. to Ext. Vert. Faun., p. 108.
A (*Protamia*) *gracilis*, Leidy, loc. cit.
A. depressa, Marsh. Pr. Ac. Nat. Sc., 1871, p. 105.
A. Newberriana, Marsh, loc. cit.

HYPAMIA, Leidy. Pr. Ac. Nat. Sc., 1873, p. 98; Cont. to Ext. Vert. Faun., p. 189.

H. elegans, Leidy, loc. cit.

PAPPICHTHYS, Cope. U. S. Geol. Survey, 1872, p. 634.

P. sclerops, Cope, loc. cit., p. 635.
P. plicatus, Cope, loc. cit.
P. lævis, Cope, loc. cit., p. 636.
P. symphysis, Cope, loc. cit.
P. Corsonii, Cope, loc. cit.

RHOMBOGANOIDEI.

LEPIDOSTEUS. *L. atrox*, Leidy. Pr. Ac. Nat. Sc., 1873, p. 97; Cont. to Ext. Vert. Faun., p. 189.

L. simplex, Leidy. Pr. Ac. Nat. Sc., 1873, p. 98; Cont. to Ext. Vert. Faun., p. 191.

L. notabilis, Leidy, loc. cit.

L. glaber, Marsh. Pr. Ac. Nat. Sc., 1872, p. 103.

L. Whitneyi, Marsh, loc. cit. (These species are all referred to *Clastes* by Cope.)

CLASTES, Cope. U. S. Geol. Survey, 1872, p. 633.

C. anax, Cope, loc. cit.

C. cyliferus, Cope, loc. cit., p. 634.

CONTRIBUTIONS FROM THE E. M. MUSEUM OF GEOLOGY AND ARCHÆOLOGY OF PRINCETON COLLEGE.

No. 2.

TOPOGRAPHIC, HYPSOMETRIC,
AND
METEOROLOGIC REPORT,

BY

WILLIAM LIBBEY, Jr.,
AND
W. W. McDONALD,

OF THE

Princeton Scientific Expedition
1877.

SEPTEMBER.

NEW YORK, 1879.

It is with great hesitation and many misgivings that we submit this Report to be printed, being conscious of the fact that errors may have crept into it unknown to us. But, at the oft-repeated request of Dr. Guyot, and the hope that the observations of scientific interest carried on during the Summer of 1877 *may be of some value, we have sent it out, knowing that it embodies the results of careful work. That it was done by amateurs who entered into the work from love of it, and who had not the experience of professional men, must be the excuse for any deficiencies which may be found in it. It is with much pleasure, however, that we take this opportunity of thanking Dr. Guyot and Professors Brackett and MacMillan for their kind encouragement and aid, both in the preparation they gave us for work in the field and in the unfolding of the results, after our return home. A number of artotypes enliven the pages of the Report, for the plates of which we are indebted to the courtesy of the photographers of the expedition, Mr. Devereux and Mr. Butler.*

WILLIAM LIBBEY, JR.
W. W. McDONALD.

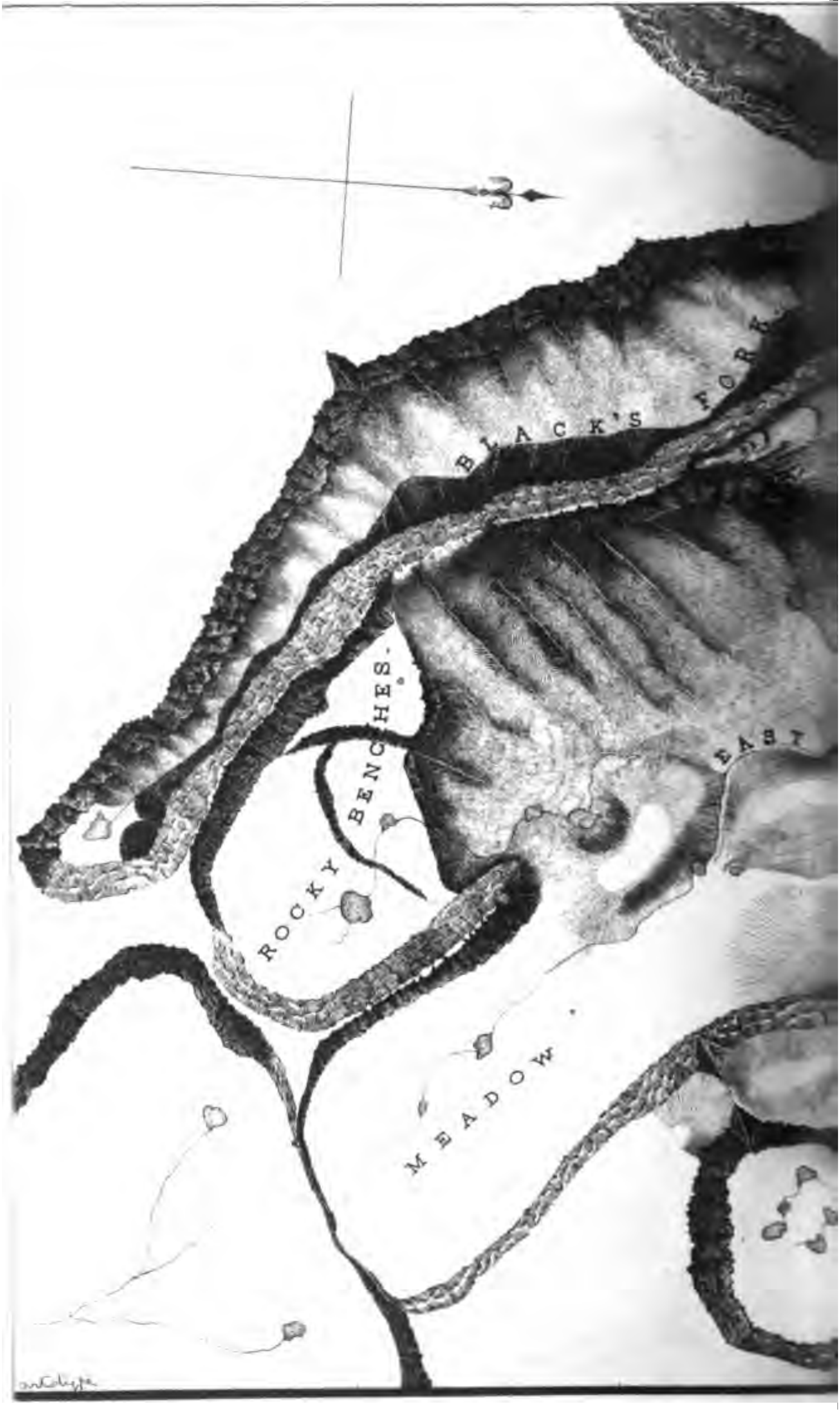
PRINCETON SCIENTIFIC EXPEDITION.

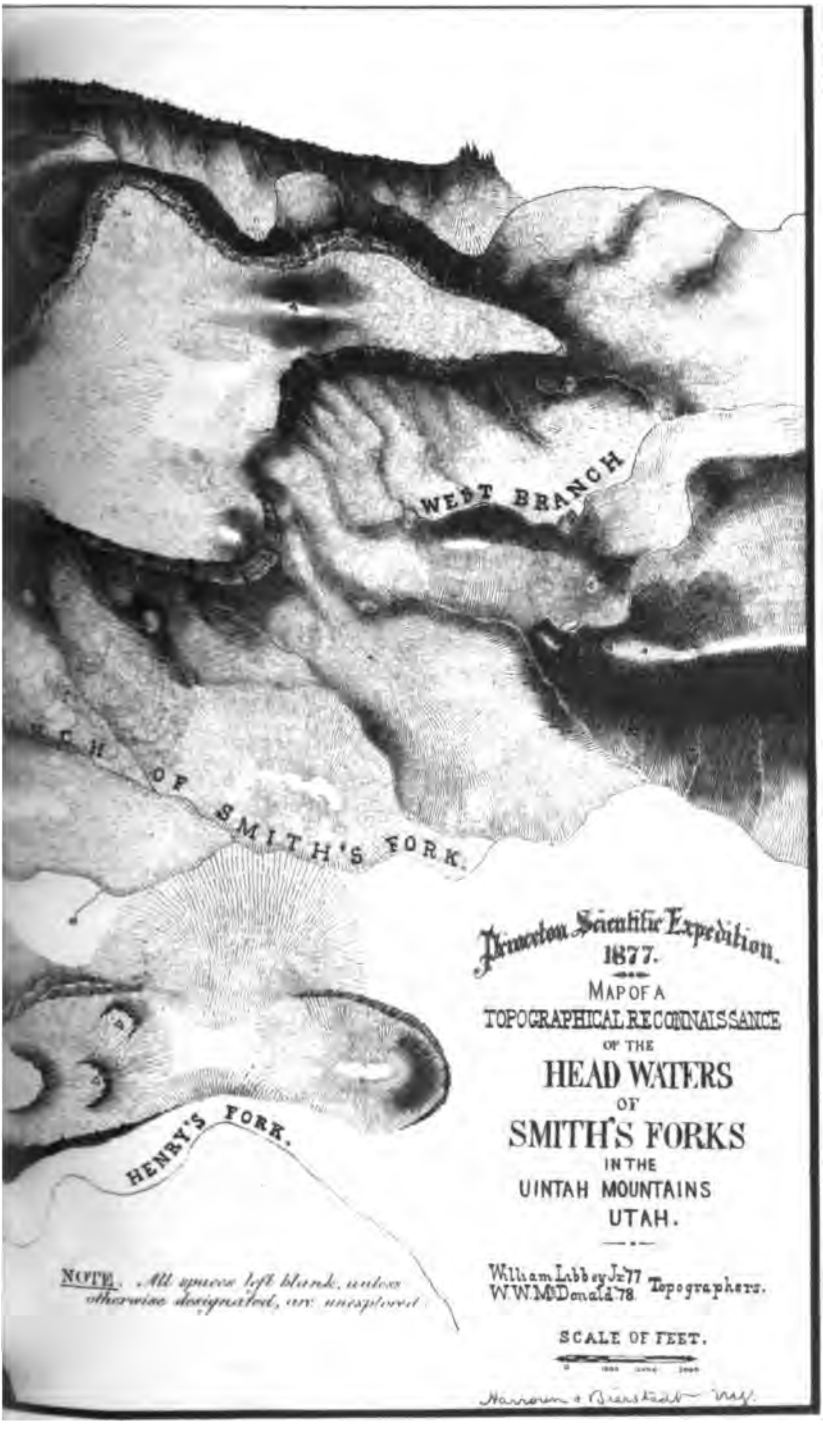
1877.

PROF. C. F. BRACKETT, M.D.

PROF. JOSEPH KARGE, Ph.D.

W. B. DEVEREUX, '73,	*Photography.*
H. R. BUTLER, '76,	
R. H. LYNDE, '77,	*Palæontology.*
H. F. OSBORN, '77,	
J. POTTER, '77,	
W. B. SCOTT, '77,	
F. SPEIR, Jr., '77,	
A. J. McCOSH, '77,	*Botany.*
C. G. GREENE, '77,	
J. S. ELY, '77,	*Mineralogy.*
F. E. PARKER, '77,	
W. DULLES, '78,	
W. F. DUNNING, '78,	*Natural History.*
D. F. McPHERSON, '77,	
W. D. VAN DYKE, '78,	
J. A. STEWART, Jr., '79,	
W. LIBBEY, Jr., '77,	*Topography, Meteorology, Hypsometry.*
W. W. McDONALD, '78,	


BLACK'S FORK
ROCKY BENCHES.
MEADOW
EAST



Princeton Scientific Expedition.
1877.

MAP OF A
TOPOGRAPHICAL RECONNAISSANCE
OF THE
HEAD WATERS
OF
SMITH'S FORKS
IN THE
UINTAH MOUNTAINS
UTAH.

William Libbey Jr. '77
W. W. McDonald '78. Topographers.

NOTE. All spaces left blank, unless otherwise designated, are unexplored.

Harrison & Bierstadt N.Y.

To the Honorable the President and Board of Trustees
of the College of New Jersey.

Gentlemen: I have the honor to submit herewith the report of the two topographers in charge of the topography and meteorology of the college scientific expedition of 1877.

The map of a portion of the Uintah Mountains, which is exclusively their work, has been reproduced by the artotype process; and, together with the numerous altitudes carefully determined, is believed to be a valuable contribution to the knowledge of the character of that chain of mountains, as yet so little known. The artotype plates are copies of but a few samples selected from the large collection of excellent photographs, taken by the photographers of the expedition. The appendix, containing a diary of the party, is given to show how faithfully the time allotted has been employed in furthering the object of the expedition. It may serve as a specimen for all the divisions, which would show a similar record.

It is a great pleasure for me to be able to state that a further examination of the palæontological results of both the expeditions of 1877 and 1878 have much surpassed my expectations. A second palæontological report is almost ready for publication. The materials for a third, containing a large number of new species of fossil plants, are nearly prepared.

It is a source of great gratification that these expeditions, while accomplishing their first object, the encouragement of scientific studies in our college, have been at the same time so fruitful in results for the advancement of science. This may justify the hope entertained that this doubly useful complement of our regular course of studies will remain a permanent feature of our College.

Very respectfully submitted,

A. GUYOT,

Director of E. M. Museum.

Princeton, N. J., September, 1879.

PRINCETON, N. J., June 1, 1879.

SIR: We transmit herewith the reports upon Topography, Meteorology, and Hypsometry, as prepared by Messrs. William Libbey, Jr., and W. W. McDonald, of the Scientific Expedition which went out in the summer of 1877 under our charge.

Together with the reports are three maps: the first containing the results of a topographical reconnaissance in the valley of Smith's Fork, in the Uintah Mountains of Utah; the second containing the triangulation of the same; the third showing the relation between Fort Bridger and the valley of Smith's Fork.

The topographical report is divided into two parts, one devoted to the work in Colorado, the other to that in Utah.

The meteorological report is confined wholly to Utah, and contains a meteorological record for part of the time spent there.

The hypsometric report is also divided into a report of the work in Colorado, then of that in Utah, and these are followed by a discussion of the barometric work.

Yours, etc.,

C. F. BRACKETT.

JOSEPH KARGÉ.

DR. A. GUYOT,
Director of the E. M. Museum.

PRINCETON, N. J., Jan. 1, 1879.

SIRS: We present herewith our joint report on Topography, Meteorology, and Hypsometry, embodying the results of our work in those departments during the summer of 1877. Accompanying the report is a map, prepared by us, giving an idea of the topographical features of the upper portion of the Smith's Fork Valley in the Uintah Mountains. This valley was chosen as a characteristic type of the valleys of this transverse mountain chain and studied as such with some care.

Leaving Princeton June 21st in the evening, we reached Denver on the evening of the 25th. Here we spent a few days in purchasing such things as we needed to complete the equipment brought from the East. The party also bought horses, mule teams, and wagons here for their proposed trip in Colorado. From this time to July 21st we spent in Colorado; measuring Pike's Peak, Mts. Lincoln, Bross, Quandary, Silverheels, Princeton, Evans and Gray; also, determining several bases. We then started with General Kargé and the Palæontologists for Fort Bridger. Our trip was made with safety and pleasure, notwithstanding a delay at Cheyenne. We fitted out at the Fort for the mountains, where we worked at the topography of the valley mentioned above until August 24th, and then commenced our return to Fort Bridger, aiming, on our return, to get a general idea of the region lying between the Fort and the mountains. The result of this reconnaissance is embodied in another map, also accompanying this report, which may serve as a hint to further and more accurate surveys of the same region. The meteorological as well as the topographical report is confined mostly to this part of Utah. The only work of any scientific value done in Colorado was hypsometric, on account of our hurried and long marches through that State. Being constrained to keep track of our party, we depended on gaining some miles in advance for an opportunity of doing our work. The work in Utah was undertaken in a more systematic way. A base line was accurately measured, and its height carefully ascertained; from either end of this our triangles stretched up the sides of the valley of Smith's Fork, and these were bound together by a network, in the measurements of which we have some confidence, not only on account of the accuracy of our little transit, but from the knowledge that the work was done with great care. We worked up one side of the valley first, and then down the other, our camp being about the centre of the large amphitheatre. The last triangle closed within half a minute of arc, which we considered excellent, from the fact of the roughness of the ground traversed and the many disadvantages under which we labored. The peculiarities of our work will be brought out fully in the body of the report. Our experiences with electricity, and the elements in general, may not have been exceptional, but they were certainly novel to us, and their faithful recital may prove a warning to future explorers in the same region. Upwards of thirty barometric measurements were made of the mountains on either side of the valley. Our series of barometric heights commenced at Carter Station on the Union Pacific Railroad, and extended from there to Fort Bridger; thence in succession to the Herd House or cattle yards of Judge Carter; to the St. Louis Mills; to Gilbert's Meadows; and to our other two camps, the one near the head-waters of the west branch of Smith's Fork, and the other at the centre of the valley of the east branch, or main Smith's Fork. Our barometers were carefully compared before and after each trip, or day's work, and the station barometer was always carried as near to the base of the mountain as was possible. A north and south line was preserved as much as possible in the relative situation of the instruments. In ascending the side of a mountain we were often enabled by means of our levels to know when we were on a line with the top of some previously measured mountain on the other side of the valley, and by measuring this point also we were often able to obtain a second measurement, which was in general very satisfactory in its comparison with the former one. Towards the latter part of our stay the rainy season of the fall came on, and heavy rains, with storms of snow and hail on the mountains, generally lasting from 10 A.M. to 4 P.M., drove us from them. Bidding them a reluctant farewell, we returned to the Fort, making measurements by barometer, sketching profiles, and making sections, with which, and with the aid of some other maps at the Fort, we finished the map of the country between the Fort and the mountains. The hypsometric and topographic work are combined in the main map accompanying the report, which has been prepared with great care. By comparing our map with that of the government survey of the fortieth parallel, it will be readily seen that it differs in some particulars from the map of the same valley given by that survey. It cannot be expected from a general survey, such as was intended in that work, that it should contain all the details of a special survey such as ours. To a person merely passing through the eastern part of the valley it presents many of the aspects given on the above-mentioned map; but the appearances in that valley are very deceptive, and a closer examination reveals the features given in our map. After the regular reports we have given an itinerary of the whole trip, believing it will be interesting to those who wish to follow us in our daily work in the West, as it combines, in a condensed shape, the diaries of both of us. Our thanks are due to Colonel Flint, commandant of the Fort; to Lieutenant-Adjutant True, Lieutenant Scott, commissary; Judge W. A. Carter, Dr. J. Van A. Carter, and Mr. R. H. Hamilton, for many courtesies and great aid in the furtherance of our work. We shall long remember with pleasure our leisure hours passed among the pleasant people of that little island in the desert, where we met so many kind friends. And the warm reception, with the kind-hearted farewells, will always raise happy memories in that division of our scientific expedition. Leaving a few days later (September 6th) we joined the rest of the party at Cheyenne: then with only a stop at Chicago over Sunday, we set our faces eastward, with little to regret and much to be happy over.

William Libbey, Jr.
W. W. McDonald.

C. F. Brackett, M.D.
Joseph Kargé, Ph.D.

INSTRUMENTS.

The instruments of the expedition were the property of a member of the party, and were as follows:

TRANSIT.—The transit was made by Messrs. Heller & Brightley, of Philadelphia, and is a *fac-simile* in miniature of their "complete engineer's transit." It is one of the instruments exhibited by this firm at the Centennial Exhibition in Philadelphia, where it took a prize. It has long compound centres, the vernier plate centre being 2½ inches long. The horizontal limb is read, by two double opposite verniers, to minutes of arc. These verniers are placed outside of the compass-box, and their openings are protected by glass windows. The vertical arc also reads to minutes. There is a 2½-inch magnetic needle, and its ring is divided into half degrees. The telescope is 6¾ inches long, with object-glass 15/16 inch in aperture; it magnifies 15 diameters, and shows objects erect, not inverted. A sensitive level 3 inches long is attached to the telescope for assistance in accurate levelling work. The telescope has a slow motion for focussing the cross wires, and is provided with adjustable stadia wires for measuring purposes, thus dispensing with chaining and taping to a considerable extent. The plates and vertical circle are provided with clamp and tangent screw movements, and the clamps on the axis of the telescope are arranged with sighting slits and indexes, so as to answer also for right angle sights. All the working parts of the needle-lifter, clamp and tangent screw movements are concealed between the plates, making the instrument more compact and less liable to injury. The height of the instrument from the tripod legs is 7½ inches. The extreme diameter of the plates is 4½ inches. The diameter of the horizontal plate at the point where the verniers and graduation meet is 3⅝ inches. The tripod is furnished with an adjustable head for precise plumbing over a centre. The weight of the instrument exclusive of tripod head and legs is 5 lbs. The weight of the tripod is 3 lbs. The instrument, with its various additional parts (such as sun-tube, screw-drivers, magnifier, etc.), is packed in a box 8 inches long, 5 inches wide, and 7½ inches deep. This box is arranged with straps to allow of its being carried over the shoulder. The constant to be added to every recorded stadia reading of this instrument was obtained as follows: Object focal length, 4⅝ inches; object-glass to centre of instrument, 3⅝ inches. Hence, if 8¼ inches be added to the stadia measurement, the measurement will then be to the centre of the instrument or plummet. We found this instrument reliable, its graduation very good, and the power of its telescope remarkable.

SEXTANT.—The sextant was one of Stackpole's best. It reads to 10″ of arc, and was provided with all the accessories usually accompanying such an instrument. The pocket sextant was made by James Green, of New York, and read to minutes of arc. Both these instruments did good service.

BAROMETERS.—The two mercurial and two aneroid barometers used were made by James Green, of New York, especially for this work, and were the best instruments he could produce. The two mercurial barometers had double verniers reading to ·002 of an inch, and were capable of recording 18,000 feet elevation. They were each packed first in a wooden case, which was then placed in a leathern sheath, and thus thoroughly prepared for rough usage and mountain work. They worked admirably together, as was shown by a long series of comparisons before and after leaving Princeton. A comparison was also made before and after each day's work, and the extreme variation was never found to exceed ·004 of an inch. We carried with these instruments a case of repairing articles, including bottles of mercury, leather, thread, etc., also six extra tubes in a box, so that in case of an accident we would not be left hopelessly in the lurch. But such was the quality of the workmanship displayed in these instruments that notwithstanding the exceedingly rough usage they received, not a repair was necessary, and they were brought home in as good working condition as when they started out. Of the two aneroids, one read on its face to 20,000 feet, with 50-feet divisions. It was also divided to 14 inches, again divided to hundredths. The other read to 15,000 feet, with 50-feet divisions, and was also divided to 14 inches, and hundredths. These two instruments were selected from six first-class ones as the best of the lot. They were tested by trials under the air-pump in the physical laboratory at Princeton, and worked well, though they have not done so well since their return.

LEVELLING-ROD.—The levelling-rod was made by Keuffel & Esser, of New York. It was an engineer's telescopic rod, and read to thousandths of a foot.

LEVELS.—The two levels were the ordinary pocket-levels, with level-tube on the inside of the tube, and an inclined mirror at the bottom of the same to reflect the image of the bubble. They were made by Mr. Green, of New York.

PRISMATIC COMPASS.—This instrument was also made by Mr. Green, and of the same pattern as is used by the United States Engineer Corps.

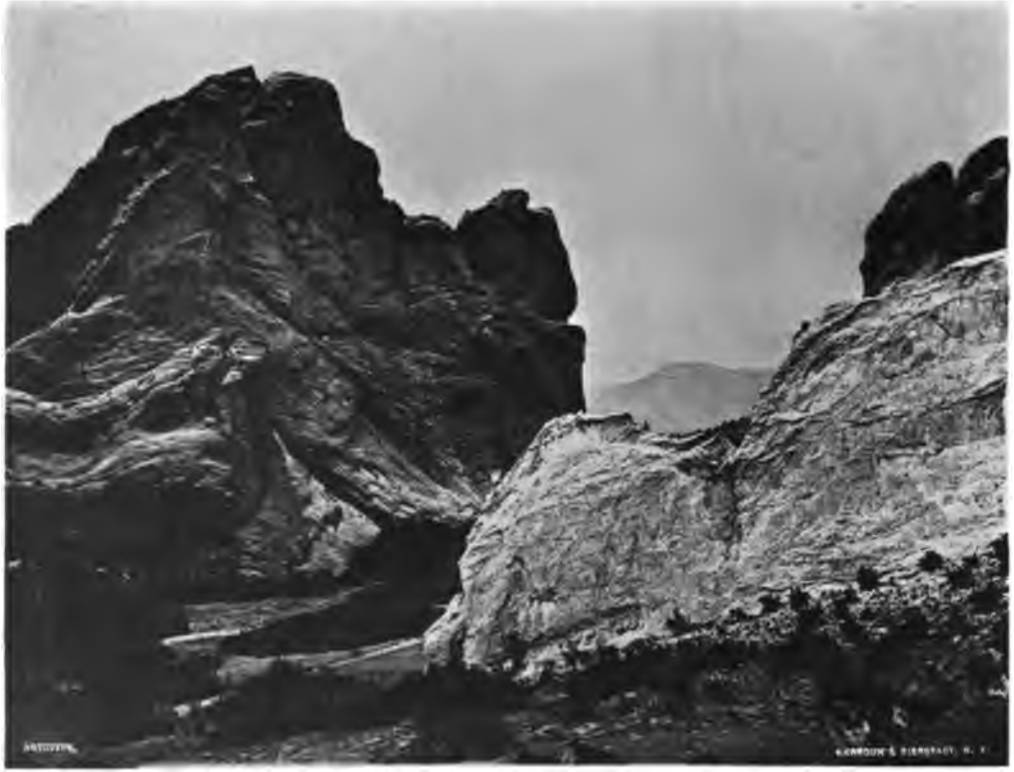
COMPASSES AND CLINOMETER.—These were made by Mr. Green. There were three small compasses for pocket use in brass cases. The clinometer was a 3-inch compass, mounted upon a square piece of brass, one edge of which served as a base for the clinometer index. This compass was also provided with sighting slits.

TELESCOPES.--These were made by Bardou fils & Cie., of Paris, having glasses of 1½ and 2 inches diameter. Both of them were pieces of fine workmanship, and were of great service on account of their clear definition and high powers.

THERMOMETERS.—These were graded according to Fahrenheit and made by Mr. Green. Each had a wooden case of its own. One of them was used for a wet bulb thermometer in meteorological observations.

TOPOGRAPHICAL REPORT.

I. COLORADO.
I UTAH.



Gateway, in the "Garden of the Gods."

TOPOGRAPHICAL REPORT.

I.—COLORADO.

OUR work in Colorado was almost entirely hypsometric; but as we rode a great many miles on horseback through the most beautiful and picturesque parts of that State, and in that way obtained an idea of the topography of the country through which our road lay, we shall give some account of it. We were materially aided in this by the Government reports of Dr. Hayden, which have left very little to be done in that region in any of the departments of scientific investigation. In this report, the plan of which has been to gather together all the information possible on each of the special points of interest that we visited, we shall aim to do little more than glance at those features which were observed by us, and therefore our description may seem as hurried as our trip necessarily was. The pictures we have inserted will almost explain themselves; but a few words will sometimes be quite proper to guide those who have never seen the places referred to. The description will follow the course of our trip, and on this account may seem somewhat disjointed; but our excuse is that there was no other course left open for us; any one, therefore, who expects a complete topographic report of this part of our work will be disappointed. All we can hope is to give such information on the mountains we measured and the places we visited as might be instructive to any one interested in the subject. With these few words of introduction we will proceed first to the description of the Front Range as seen from Denver, and then to a nearer view of its structure and of that of the land to which it forms a border.

As one approaches the Rocky Mountains from the prairies, the Front Range is the first object which greets the eyes; and it is rather a pleasant sight after the long journey over the plains. This feeling is also mixed with surprise at the sudden change from plain to mountain, the cause of which has been a puzzle to many a traveller. The abrupt change from plain to mountain is not more sudden, however, than the change in the geological composition of the two systems under consideration. The mountains rising along the border line present in their rough and precipitous faces the strong, bold outlines produced by the metamorphic rocks, the granite, gneiss and the shists; while the sedimentary rocks at their bases, the limestones, shales, slates, clays and chiefly sandstones, present a very different appearance.

This border line extends in a nearly north and south line about twenty miles west of Denver, and is admired for the beauty of its outlines. The rapidity of its slopes (a marked feature of the chain) afford a grand opportunity for the display of the effects of erosion, the summit of the range being in many cases scarcely ten miles from the edge of the plains. Any one looking at the map of Colorado will also be struck by the beautiful arrangement of these chains *en echelon*.

Geologists tell us that this range was first elevated from the sea, and then that all these sedimentary rocks were deposited against their base. These sedimentary rocks at their point of contact with the granites are not horizontal, but have been turned up on end by the force exerted by the granite mass, against which they were deposited, when it lifted them to their present positions. Their slope to the east from this point is not more than 60° at any place. They form the basis of the great plain, and were once the bed of the sea which covered them, and which on receding left those thousands of feet of sediment to be carved out and carried off by the ice and water, which have left such wonderful traces of their power in this western country.

The first feature of the lowlands that strikes the eye is the low series of hills of a very even line of elevation, forming a sort of horizon or belt near the foot of the mountains, cut at intervals by the streams which descend from the mountains. The ends of these hills that overlook the streams being afterward rounded, give each section a long, gently curved line at their upper surface, which has earned for them the rather unfortunate name of "hogbacks." They seem to be a very natural boundary line between the two geological systems here brought together.

It is now believed that the sedimentary rocks, the ends of which are now exposed to our view along the eastern side of this valley, must have extended very much farther into the mountains, and that after the elevation of their mass they were partly removed by erosion. The thickness of these layers is given by Dr. Hayden's surveys at 7000 feet.

From the consideration of these general features let us turn our attention to the various phenomena as seen when travelling along between the granite and the sedimentary rocks. No one can obtain an adequate idea of the wonders of this famous strip of country until he has seen it for himself, and it would be hopeless for us to attempt a description that would fully convey the impression produced by these masterpieces of the work of erosion. We shall therefore be content with the scientific part of the description, leaving the imagination to fill up the blanks.

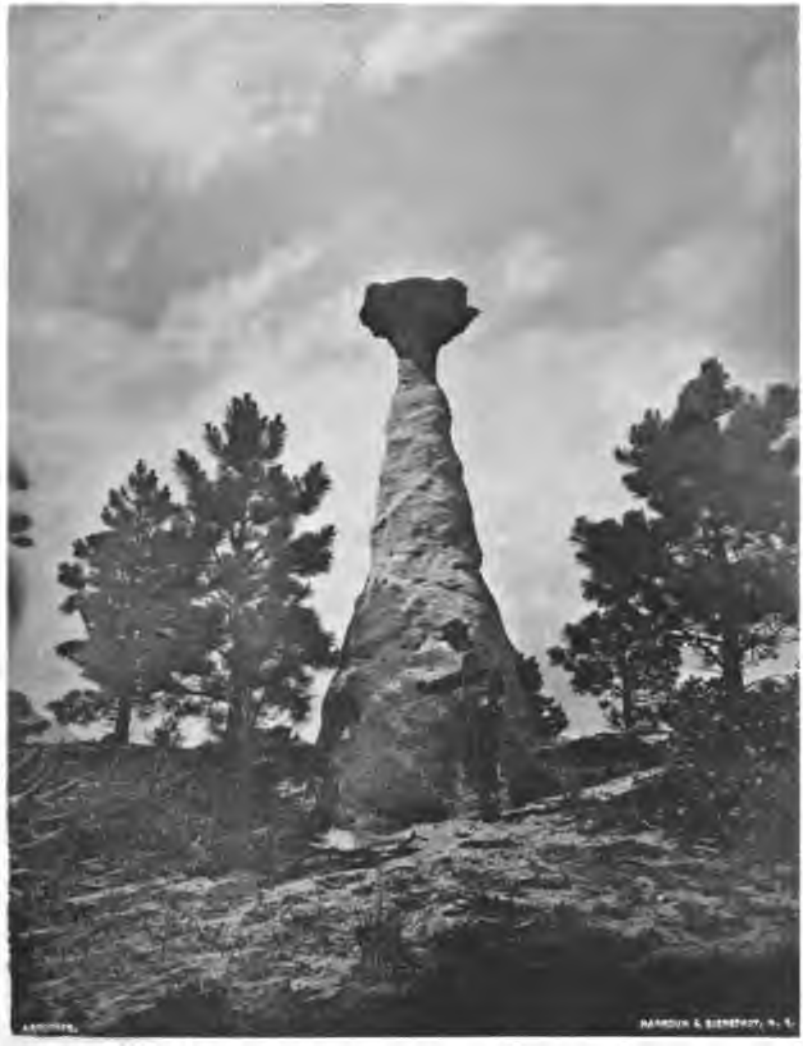
The Front Range is really broken but once below Denver by a deep cañon, where the Platte rushes from the South Park through this narrow path to the plains. Below this point, on the road to the south, we cross the low divide which separates the Platte from Plum Creek, and soon descend into the valley, whose curiously carved monuments, of which we will speak below, make it so attractive.

About half-way between Denver and the Garden of the gods we find the divide which separates the waters of the Platte from those of the Arkansas. This slight elevation of a little over 1000 feet above Denver controls the flow of the tributaries of those streams until they reach the open plains to the north and south of this point, when they take the direction of the long gentle slope to the east. To the south of this divide these monuments increase in number until the Garden of the gods is reached, which owes its name to the grand display of these singular objects at that place.

These monuments seem to have been formed in several ways, principally, however, by erosion; these isolated parts have been left because they were either of harder material than that surrounding them, or more able to resist meteoric influences, or because of their position with regard to the currents. They seem to be an aggregation of quartz grains and pebbles loosely held together in a nearly circular column, which tapers from the thick base towards the top. This shaft is surmounted by a cap of rust-colored sandstone, which owes its greater size to the oxide of iron that forms a cement, binding the grains together. This sandstone being on that account a much harder compound than the layers below it has resisted erosion to a greater degree. The smaller monuments here described vary in height from 10 to 20 feet. There remain, however, some other forms which must not be omitted in this description, and those are the castellated forms of the larger table buttes or "mesas." These massive objects are from 100 to 250 feet in height, and are sometimes capped with a layer of purple porphyritic basalt. They rise from the beautiful green meadows, and their almost perpendicular sides give them an appearance which is particularly impressive just at sunset.

There seems to be but little doubt that this line of upturned strata exists throughout the whole length of the Front Range, though hidden in some parts of its length. It is separated from the Front Range by a valley, the portion of which that lies fifty miles to the north of Colorado Springs is the most picturesque, and will always retain its celebrity, on account of the striking forms of erosion just described.

Pike's Peak is situated just west from Manitou and the Garden of the gods. It is a mountain composed of fine-grained reddish granite, which is believed to be metamorphic. The appearance of some fragments of sedimentary rock at its foot gives rise to the supposition that in Silurian times there was a bay at its base, this being the point farthest west at which these rocks are found in this range. It is also the point where the summit of the range approaches nearest to the plains; the upheaving force seems here to have been expended in elevating the older layers above the sea, making them form part of the shore-line and driving the sea more to the east; whereas to the north of this the force being more distributed caused a more general elevation. The same is supposed to be true with regard to the Mt. Evans group at



Single Butte, in "Garden of the Gods."

the other extremity of this line, both of these mountains seeming to be centres of action.

The Ute Pass lies to the north of Pike's Peak, and is a very beautiful and picturesque pass, cut out of the granite along the course of the "Fontaine qui bouille," and is the road to South Park, which comes to our notice next.

South Park is a large area of depression, of the general shape of an ellipse, having a diameter of 45 miles from northwest to southeast, and of 35 miles from northeast to southwest. Its area is about 1200 square miles. It is not a perfectly level plain, but has a general slope from the northwest, almost to the base of the Front Range, where lies the bed of the Platte. This accounts for the curious drainage system of the Park, as a moment's glance at the map will show. The rivers flow down the long slope of the western side till they reach the short counterslope of the eastern side, and then turning almost at a right angle flow to the northeast. The general elevation of the Park is about 8000 feet, though it reaches 10,000 feet in the western part, and goes down to 7000 where the Platte cañon pierces the Front Range. It is surrounded by mountains, the bases of which bear the marks of its having been at one time the bed of a lake, not only from the form of the basin, but mainly from the sedimentary rocks found deposited there. The surface of the plain is quite irregular, being cut up by numerous low ridges, which are generally parallel to each other. In the central portion there are also cross-ridges of trachyte, showing the existence of some extended fissure from which this igneous overflow took place. Otherwise the sandstones of the Park are very little disturbed.

Before describing either the Park Range or the Sawatch, let us look at the valley of the Arkansas, which lies between them. It starts at the Tennessee Pass from a basin of granite, and has been formed partly by fissure and partly by erosion. This valley varies in width from 8 to 10 miles, and is cut down a hundred miles through the mountains to Poncho Pass. It affords one of the finest fields for the study of glacial action in the West. Dr. Hayden thinks * that the

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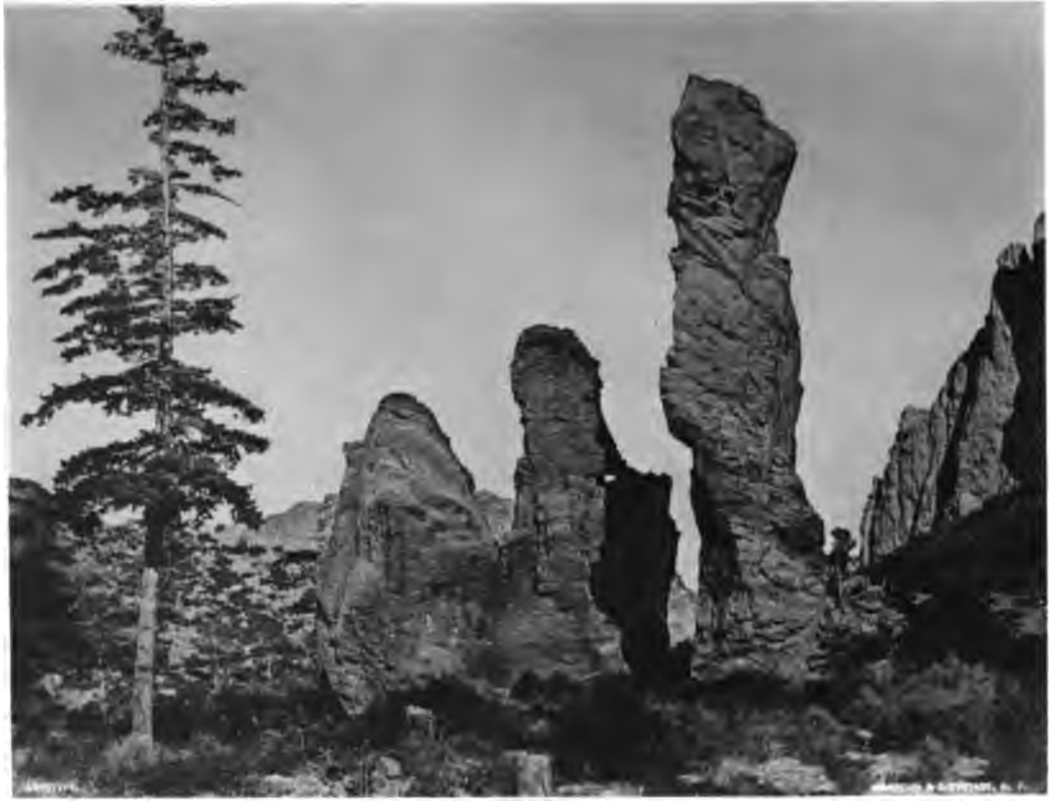
* U. S. Geog. and Geol. Survey, Hayden, 1873, p. 39.

2

Park Range is a member of a great anticlinal, of which the Sawatch is the nucleus or central axis. This valley coming between these ranges was thus first opened by fissure, and then the enormous work of erosion commenced. At first the valley must have had a huge glacier running from north to south through its length, as there are still traces of such a glacier in the markings on the sides of the mountains and in the drift matter on its slopes. Then part of this valley formed the bed of a large lake, as is shown by the deposits in the bottoms where they are exposed. This lake occupied the lower half of the valley, and when it was drained off through the opening now traversed by the Arkansas River the heavy and coarse material at the upper end and the finer drift matter at the lower end were exposed. The valley has many rounded oblong hills, which are covered by débris, and range in height from 500 to 700 feet. After this first large glacier came others, which might be called secondary, and occupied the beds of the present tributary streams of the Arkansas. Each one of these is marked by large moraines, and where exposed, the glaciation is magnificent. The masses of rock which have been transported by these agencies are incredibly large, often reaching 100 feet in diameter. The largest of these valleys is that of Lake Creek. This whole valley must have been occupied by a glacier of from 1000 to 1500 feet in depth. The terminal moraines of this glacier are remarkable for their size. Everywhere the traveller is hindered in his journey by mounds, ridges, basins and boulders, the latter often from 20 to 50 feet in diameter. Worn rocks are also exposed, showing the effect of ice on their surfaces. The upper part of the valley has two lakes in it, whose basins were doubtless formed by the glaciers. These lakes are about 350 yards apart and connected by a small stream. The lower of these lakes is the largest, being 2½ miles in length and 1½ in breadth, its greatest depth being 75 feet. The upper lake is 1 mile in length and ½ mile in breadth, having a depth of 79 feet.

On either side of this valley are the Sawatch and Park Ranges, the origin of which we have already indicated. The great mass of the Sawatch Range is a granite nucleus, with now and then a dike of some foreign material. There is one



Glen Eyrie.

very remarkable feature about this range, and that is the superficial covering of earth which reaches clear to the summits of many of the peaks. About the middle portion of the range are situated the three prominent peaks of Princeton, Yale, and Harvard; respectively, 14,208, 14,187, 14,375 feet above the level of the sea.

Its companion, the Park Range, is very irregular in height, being much cut to pieces by erosion. One of its marked features are the trachytic beds which are interstratified among its other rocks; these layers have, in places, a thickness of 1000 feet. Another peculiarity is the presence of the large amphitheatres at the head of the streams which arise on its eastern slope. It is very precipitous on the western side, its gentle inclination to the east giving rise to the supposition of its being an anticlinal.

Little remains for us to do now but to glance at that knot of mountains which centre in Mt. Gray, forming a connecting link between the Front and Park Ranges, two of whose peaks we measured: Mts. Evans and Silverheels. As the main crest of the Front Range approaches Mt. Torrey, it suddenly rises from its usual height of about 12,000 feet to the magnificent elevation of over 14,350 feet. From Mts. Gray and Torrey a very imposing and high ridge runs out to the east, which reaches its climax in Mt. Evans. From Mt. Gray the Range to near Mt. Lincoln is much higher than in any other part. We crossed the Argentine Pass at 13,100 feet, and the Hoosier Pass at 12,364 feet. Mt. Silverheels is on this ridge just before it reaches Hoosier Pass, and is also the centre of another group of mountains. It might be said that the main ridge reaches here its maximum height, for a pass at this point is 13,650 feet. Near Mt Lincoln the main ridge meets the Park Range at right angles, and we shall leave it at this point to follow the Park Range far enough to mention the three mountains we measured on its crest. The Park Range has four mountains at this point, all within a short distance of each other, which are above 14,000 feet; of these we measured three: Mts. Quandary, Lincoln and Bross. It is also noted for its high passes, the number of its peaks, and the amphitheatres at the heads of the several valleys. This brings us to the end of our work in Colorado.

PICTURES.

The pictures we have been able to give are as follows:

THE GATEWAY IN THE "GARDEN OF THE GODS." The two large remnants of a perpendicular stratum of red sandstone which was cut in two by erosion form this gateway. In the foreground is seen a stratum of white sandstone, also on its edge. In the distance Pike's Peak is dimly outlined.

A SINGLE BUTTE. This has already been described, and will be readily recognized.

GLEN EYRIE. We give two views; one of the "needle rocks," as a remarkable example of the work of erosion, and the other of the edge of one of these upturned ledges which gives a fine idea of its structure.

MT. PRINCETON. This mountain is in the Sawatch Range. It is noted for its symmetry. The broad valley of the Arkansas is in the foreground.

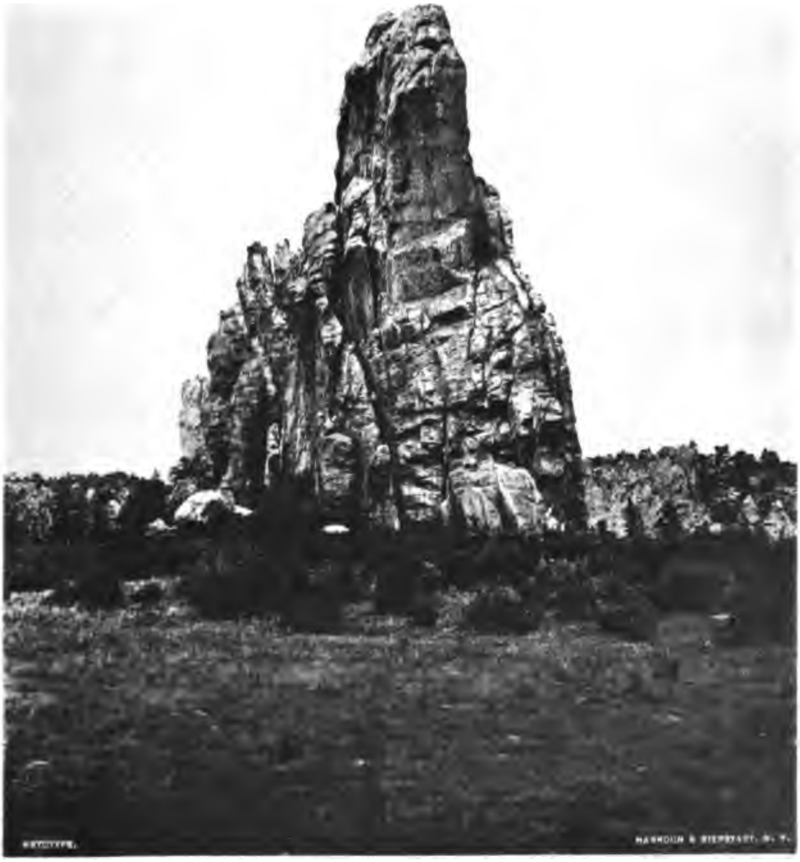
THE WESTERN TWIN LAKE. This is the smaller of the two lakes. Two unnamed peaks of the Sawatch chain are shown in the background.

WESTERN SLOPE OF THE CONTINENTAL DIVIDE. This view is in the Twin Lake region.

BLUE RIVER AND MOUNTAINS. This view is given as a specimen of a deep and wooded valley. The slope of the mountains, it will be noticed, is very steep. The height of the ridge above the valley is 3000 feet.

MT. LINCOLN. The view is taken from Hoosier Pass, and embraces Montgomery Gulch on the right hand side of the picture. The trachytic dikes spoken of in the report are well brought out on the side of the mountain.

MT. GRAY. The view is taken from the Argentine Pass, and shows Mt. Torrey on the right.



Glen Eyrie
No. 11.

II.—UTAH.

Concerning the topography of the Uintah Range, however, we will go a little more into detail; especially in regard to the valley, which we endeavored to study with more care than any other part. A careful comparison of what may be said here with the map before one's eyes, will give an adequate idea of the many beauties, as well as the remarkable structural features, of the valley. We regret very much that we are not able to give any pictures of this strange place. Prof. O. C. Marsh says* of the Green River Basin, in the March number of the *American Journal of Science and Art* for 1871, p. 197:

> "While descending the northern slope of the mountains toward the great Tertiary Basin of the Green River, which lay in the distance 2000 feet below us, we passed over a high ridge, from the summit of which appeared one of the most striking and instructive views of geological structure to be seen in any country. Sweeping in gentle curves around the base of the mountains from where we stood, many miles to the northward was a descending series of concentric, wavelike ridges, formed of the upturned edges of differently colored strata, which dipped successively away from the Uintahs, those nearest to us 40° or more, those at a distance seeming but little,—altogether a scene never to be forgotten. Apparently, we had before us a geological series from the Palæozoic to the Tertiary."

Fort Bridger is situated in this valley, about fifty miles to the north of the point from which, we suppose, this view was taken, and we can do no better than to quote Prof. Marsh once more, when he says:

> "Fort Bridger is situated at the northern base of the Uintah Mountains, about 7000 feet above the sea. The surrounding plain is part of a great basin of denudation, washed out of light clays and soft sandstones of the Tertiary age; the deposits in one of the great fresh-water lakes that replaced the Cretaceous sea, from which the mass of the Rocky Mountains emerged. Remnants of the strata removed may be seen at various points around; some in the shape of flat, isolated buttes, and others forming benches resting horizontally against the sides of the mountains. These fragments serve to show the great original thickness of this lake deposit, which cannot have been less than 1500 feet, and may have been much greater."

The Uintah Range is a system which leaves the Wahsatch Mountains in about latitude 40° N. with an elevation of nearly

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* See also Dr. Jos. Leidy, Geol. Survey of the Ter., 1872, p. 651.

12,000 feet, and runs east throughout its whole length; at first, a little north of east and then with a single bend going southeast. It seems to reach its maximum in Gilbert's Peak, which cannot be far from 14,000 feet of elevation. From this point it descends till it terminates near the Green River. The range forms an immense ridge, with an almost level, but badly broken up belt on top, which has an elevation of about 6000 feet above the table-land on the north, and apparently about 7000 feet above the similar table-land on the south. The valleys are numerous, deep, and narrow, except at the head, and extend quite to the summit. Between these valleys on the north are the transverse and generally unbroken ridges by means of which the summit can be reached by a gradual ascent. On the south these transverse ridges seem to be very much broken toward the summit. The opposite valleys start from nearly the same point, and have between them only a thin precipitous wall, which erosion is slowly removing. Gilbert's Pass at the head of Smith's Fork is such a point, where the wall has been sufficiently worn away to admit of the construction of a road across it. There are few if any other such places at present.*

The sides of the ridges which bound these valleys are generally masses of boulders and débris *in situ*, making their ascent almost an impossibility, and travelling a very difficult operation. The country to the north from the end of these ridges descends in a series of terraced plateaus of soft earth, the slopes of the terraces being generally as steep as the earth will stand.

The whole top of this elevated belt of country is very badly broken up by cracks in many places, affording a fine chance for the study of dynamical geology. It seems to have been the favorite battle-ground of the elements, some of the peaks having been literally crushed into a mass of huge boulders.

Our topographic survey in this valley has been carefully worked out and embodied in the principal map which accompanies this report. The diary of the trip will give the daily occurrences, and for this reason it will only be necessary here to indicate the route taken and the bases which were

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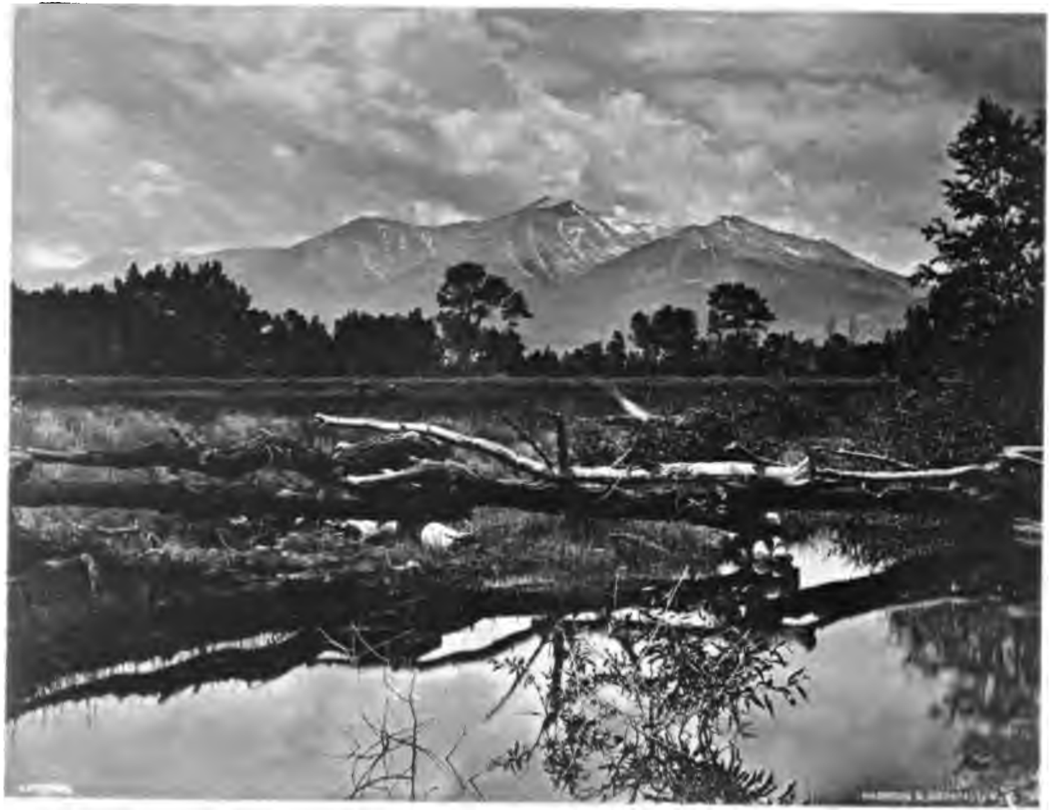
* See Geol. Survey of 40th Parallel vol. ii. p. 257.



Mt. Princeton.

measured. Starting out from Carter's station, and using the height given by the Union Pacific Railroad (6530 feet), we ascertained the height of Fort Bridger to be 6714·8 feet. Then by a series of half-day corresponding observations and comparisons we moved on up into the mountains, heading toward Gilbert's Meadow, which, although we found it a good camping place, was not a point for active work, and hence we had to move on to a camp at the head of the west branch of Smith's Fork. We remained there till the place of our day's work became too far off for us to reach it comfortably. We then moved to the centre of the East Branch of Smith's Fork's valley, upon one side of which we had been working. From this base we operated most successfully, till we were forced to make our way back on account of the storms which occurred daily. We went back slowly, verifying our work, and returned to Fort Bridger to find our circle of elevations come to a close within two feet. Although the result may be an accident, still this speaks for itself. The barometric bases measured were as follows:

Fort Bridger	6714·8
St. Louis Mills	8557·6
Gilbert's Meadow	9733·2
West Branch of Smith's Fork	10626·0
East " " " "	10555·0
Steel's Mills	9357·0
Herd House	7085·0

The points measured from these bases were as follows:

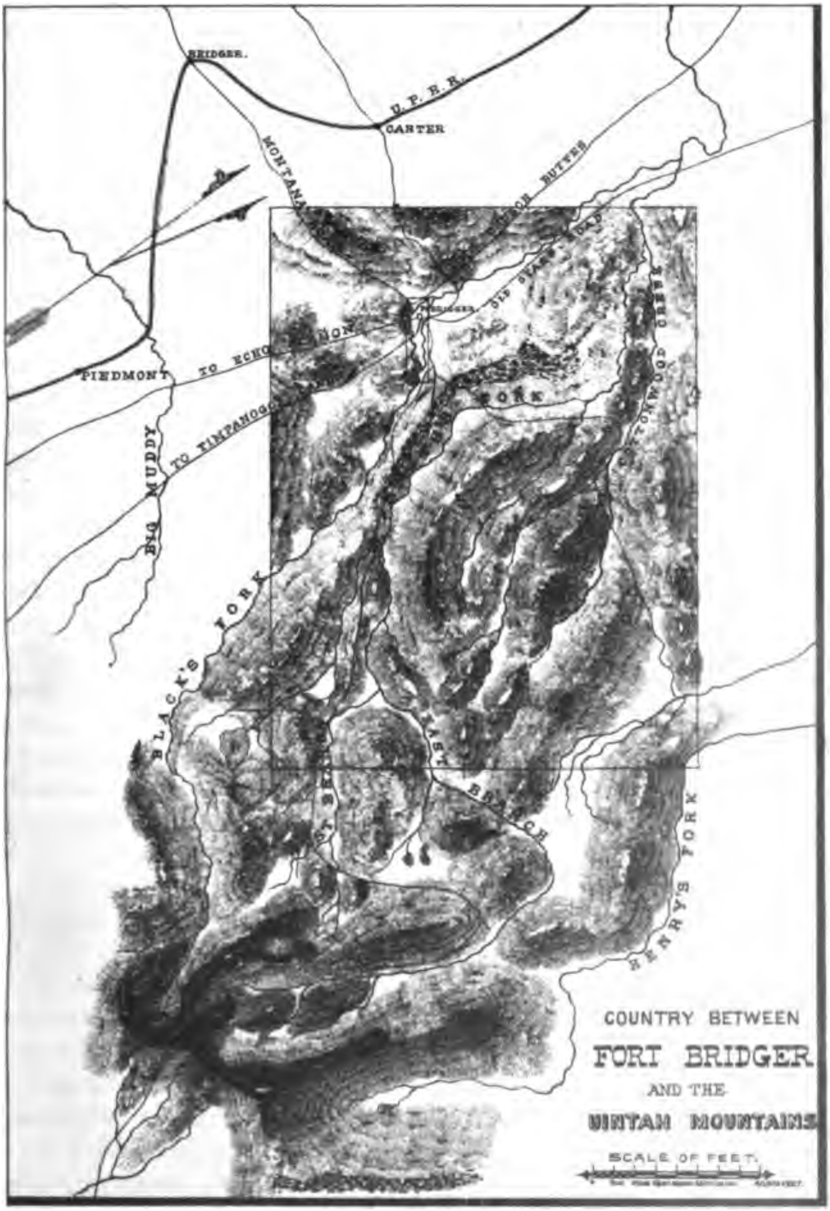
No. I	10796·4
" IV	10814·0
" V	11910·0
" VI	11605·5
" VII	11397·0
" VIII	12804·8
" IX	12799·5
" X	13052·0
" XI	12804.0
" XII	12622·9
" XIII	12688·2
" XIV	12245·6
" XV	13069·7
" XVI	12401·9
" XVII	12528·8
Timber Line	11144·4

Geologically considered, the Uintah Mountains are the result of an upheaval which followed closely the Carboniferous Epoch. In this upheaval a great belt of country from 25 to 30 miles wide was raised to its extreme elevation, without materially disturbing the inclination of the strata; it being possible that the present dip, which increases from 3° at the summit to 6° at the south, is the same that existed before the mountains were lifted. Upon both edges of this belt the strata are broken axially, dipping on the north side 38° to the north, 12° 12′ west, from the true meridian, and on the south about 43° to the south, 12° 12′ east, in the longitude of Gilbert's Peak. The main anticlinal axis is on the north edge and in the same longitude bears north 77° 48′ east from the true meridian.

The uplifted beds, as displayed by the lateral erosion, are almost entirely composed of a brownish red—rarely gray—sandstone of the subcarboniferous epoch, scarcely fossiliferous, which is metamorphosed into quartzite along the anticlinal cracks. They are of very great thickness, from 2500 to 3000 feet being visible near the summit.

Along the main anticlinal axis, and especially across the uplifted belt previously alluded to, are numerous lateral cracks that have been the starting-points of an amount of erosion that seems wonderful. They have been worn into enormous amphitheatrical basins from 2000 to 3000 feet deep, from two to three miles wide at the head, which gradually widen till they reach a point some four or five miles down the valley, and then again they come together in a cañon or precipitous valley, which continues for some eight or ten miles below. Those on the north are generally worn quite across the axis into the high belt beyond.

The large basins, previously described, range along either side of the summit line, and thus have a direction considerably oblique to that of the prevailing winds, and, in consequence, the amount of snow which drifts into them during the winter must be enormous. At such an altitude this snow melts comparatively slowly, and furnishes an almost continuous supply of water to the very numerous mountain streams, much of it having been first caught in the multitude of small lakes which are sprinkled along in the basins. On



COUNTRY BETWEEN
FORT BRIDGER
AND THE
UINTAH MOUNTAINS

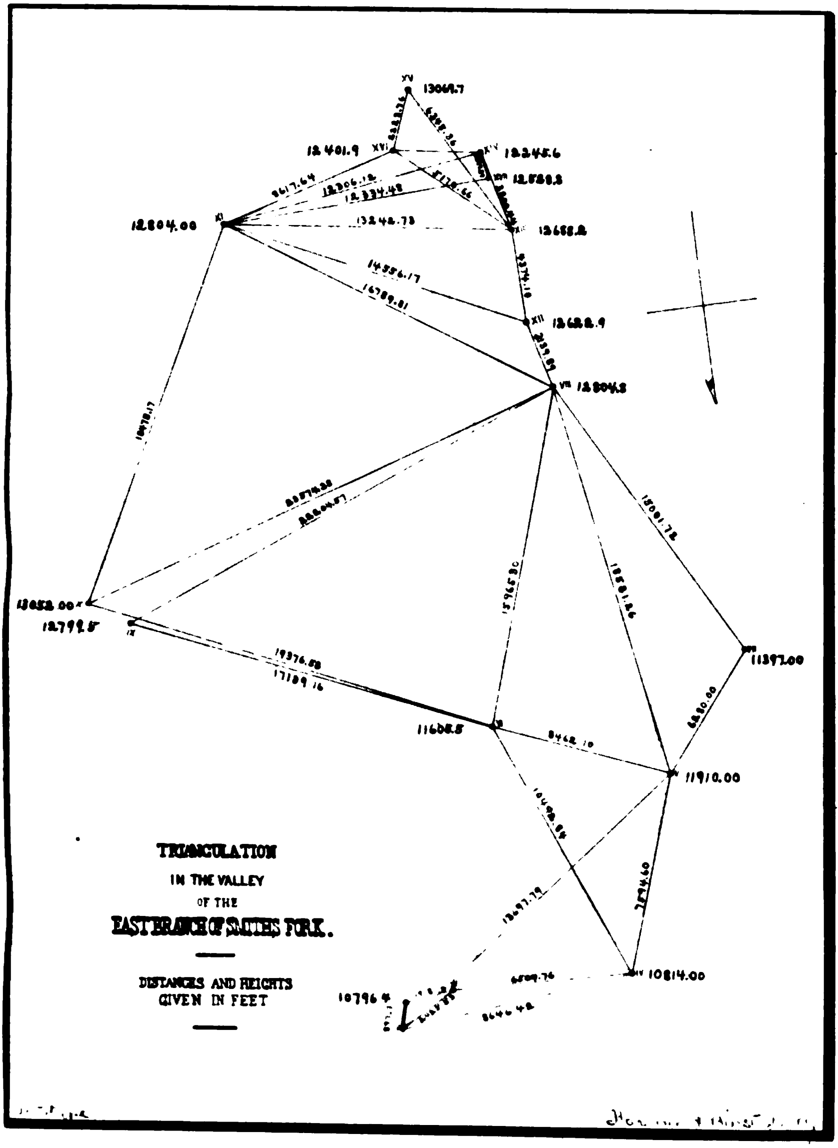
the north side there is a great deal of marshy land in these basins; but on the south the water, having to make about 1000 feet more descent, runs off too rapidly to leave any marsh. This circumstance, combined with the greater heat of the southern exposure, makes many of the smaller streams on that side run dry early in the season. The streams heading in these mountains are characterized by main features which are common to all. They are generally quite small, and, taking their rise in the summit basins, they flow on the north side, through narrow gorges with steep, heavily-wooded slopes, until they emerge from the foot-hills in the terraced plateaus which abut against the base of the range. Above the plains their water is almost pure, from the fact of its flowing only over sandstone. This quality, together with its great coolness, makes the head-waters of these streams the favorite abode of a very superior kind of mountain trout. Below the upper limit of tree growth, which is at about an altitude of 11,000 feet, the mountain ridges are covered with a dense forest, very much interspersed with small open meadows, with their grass often spreading itself for a considerable distance into the timber.

The valley bottoms are rich and pretty generally covered with grass; willow and cotton-wood trees grow near the water, with groves of pine on the mountain slopes. Everywhere, even to the borders of the snow-banks almost at the mountain heights, there is a luxuriant display of flowers, and grasses thrive along the top of the ridges, above the limit of tree growth and quite up to the summit of the range.

The soil of the plateaus between the streams is almost exclusively yellow marl, mingled with, and overlain in many places by broad lines of drift from the mountains. It is quite rich, and, under different climatic influences, fit to sustain vegetation. At present only sage-brush, grease-wood, and bunch-grass grow upon it.

The whole of the mountain slopes, from the edge of the terraced plateaus to an altitude of about 11,000 feet, are covered with extensive forests of white and yellow pine, spruce, red cedar, hemlock, and aspen. Nearly all of these woods were of young growth; thus giving evidence that extensive fires have raged here at intervals over a long period of time.

We commenced our triangulation in Smith's Fork Valley by establishing a base-line on the top of the long ridge which runs between the east and west branches of the river. This line was measured very carefully. A difference of $\frac{3}{10}$ of an inch only was found between the several measurements. From the ends of this line our triangles stretched up the side upon which our camp was situated, and across to the other side. It will be seen from the triangulation map given in the report that some parts of the valley figured in the main map were not reached by us; these we were enabled to fill in from sketches which we took from several points, as was our custom whenever it did not rain too hard. The height of No. 11 was ascertained from the top of No. 12, which was seen to be nearly on a level with it, so nearly that the small fraction of a foot given fully covers the difference. Where it was possible, we of course measured all the angles of our triangles, but as we never reached the summit of No. 11, on account of its precipitous sides, we could not make the measurement of the angles centering there. It formed, however, a fine triangulation point, as it had a sharp, spire-like head, which was situated just at the summit of cliffs rising perpendicularly almost 2000 feet from the valley below. We experienced little difficulty in finding our monuments, as the air was remarkably clear when we could work, and probably this accounts for the accuracy of our triangles; they closed within half a minute of arc, and, as our transit only read to minutes, we thought they would answer our present purpose. The measurement of the triangles was always repeated three times and the mean of the three readings taken. Compass directions of the lines were also taken when the electricity permitted. We had two camps in our work in this region; one in the little rounded valley at the head of the west branch of Smith's Fork, on the left-hand bank; the other on the little hill directly at the base of No. 11, on the lower side of the hill, about twenty yards from the right-hand head of the east branch of the same river, at a point a little above the place where it joins the other head. The topography of this valley we have found very hard to represent on paper by means of topographical emblems on account of several features which seem to be entirely peculiar to it—we refer



TRIANGULATION
IN THE VALLEY
OF THE
EAST BRANCH OF SMITHS FORK.

DISTANCES AND HEIGHTS
GIVEN IN FEET

to the very precipitous sides of the valley—and others not frequently seen elsewhere. These we have represented according to our best understanding of them, and it is hoped that the larger map, together with what is here written concerning the valley, will need no further explanations. A second map has been prepared, in which are embodied the results of our sketches on our road back to Fort Bridger, together with such information as we could obtain from the inhabitants, and an old map which Judge Carter was kind enough to lend us, which latter, however, we found incorrect in some particulars. This map we give as a mere hint as to the relation between Fort Bridger and the Smith's Fork Valley. The third map contains the skeleton triangulation of the main map. In this map the distances and heights are given in feet. As the heights have been given already we will only here repeat the distances:

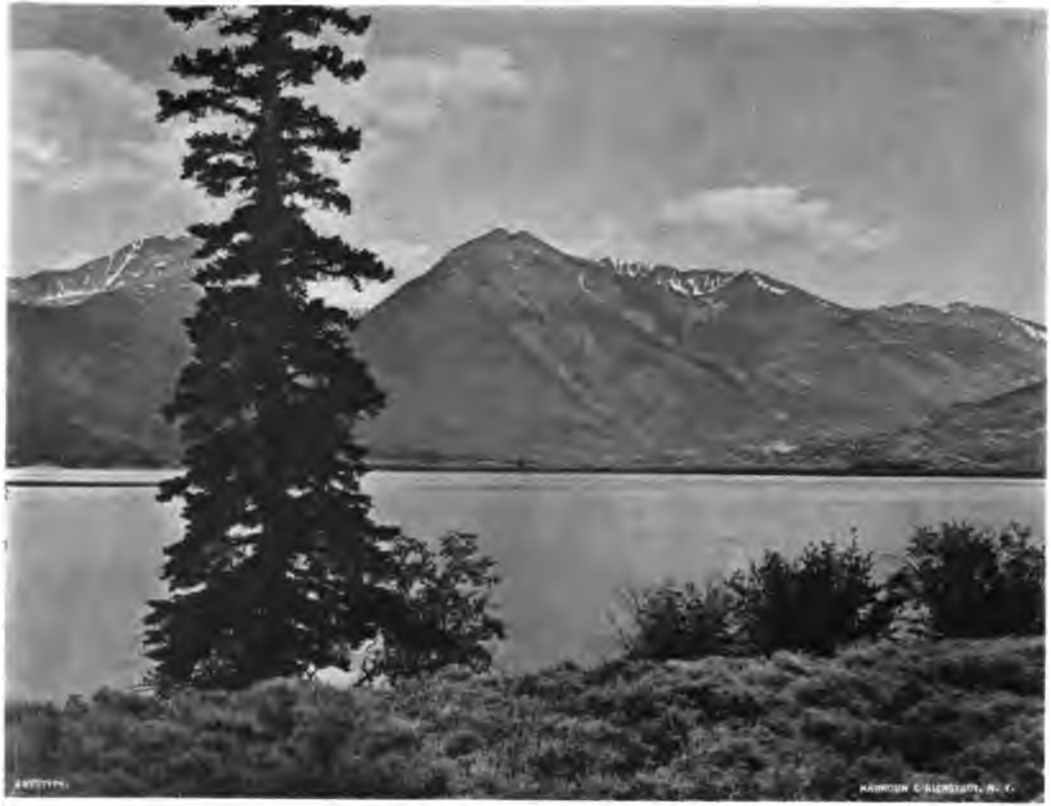
Base-line,	897·71	(6–8)	15965·30	(11–16)	8617·64
(1–3)	1918·73	(7–8)	15001·72	(11–17)	12334·48
(2–3)	2425·53	(6–9)	17139·16	(8–12)	3139·89
(3–4)	6509·76	(6–10)	19376·58	(12–13)	4374·10
(2–4)	8646·42	(8–9)	22204·57	(13–14)	3800·44
(3–5)	13697·79	(8–10)	23574·38	(13–15)	6348·36
(4–5)	7594·60	(10–11)	18478·17	(13–16)	5170·66
(4–6)	10492·84	(11–8)	16789·81	(15–16)	2223·76
(5–6)	8462·10	(11–12)	14556·17	(14–17)	1299·89
(5–7)	6280·00	(11–13)	13242·73	(14–16)	3966·87
(5–8)	18581·26	(11–14)	12306·12		

A noticeable feature of this region is the scarcity of birds, reptiles, and insects. We saw only a few snakes and lizards on these plateaus. Musquitoes are very numerous in the months of June, July, and August, after which, we understand, they disappear. The deer-fly is a ferocious insect, very much like the common horse-fly, but larger and with irridescent colors, sometimes yellow, green, and red being banded together on its head. They go in swarms, attacking both man and beast, and are a terrible scourge to animals.

We have chosen to name one of these peaks (our point No. 11) Santa Anna Mountain, from our faithful Mexican guide.

HYPSOMETRICAL REPORT.

I. COLORADO.
II. UTAH.
III. BAROMETRIC WORK.



Western Twin Lake.

HYPSOMETRICAL REPORT.

I.—COLORADO.

Our hypsometric work was entirely done by means of mercurial barometers. In Colorado this was done very hurriedly as to time, but not as to carefulness. We measured Pike's Peak, Mt. Lincoln, Mt. Bross, Mt. Silverheels, Mt. Quandary, Mt. Princeton, Mt. Gray, and Mt. Evans, with very fair results, as will be seen by the comparison which we make with the heights of these same peaks as given by other observers. We give this comparison in a tabular form, with the height of the two bases measured by us, as well as their heights as given by others:

	Princeton.	Hayden.	Wr. and Wy.*
Manitou	6351·00	6357·00	....
Pike's Peak	14147·28	14146·56†	....
Alma	10364·50	....	Wr....10254·00
Mt. Bross	14255·20	....	....
Mt. Lincoln	14297·80	14297·00	Wy....14307·00
Mt. Silverheels	13861·00	13897·00	Wy....13832·00
Mt. Quandary	14281·00	14269·00	....
Mt. Princeton	14208·90	14196·00	Wr....14041·00
Mt. Evans	14353·30	14340·00	....
Mt. Gray	14363·30	14341·00	Wy....14319·00

* Wr., Wheeler. Wy., Whitney. † U. S. Signal Service.

In many cases our measurements vary no more than ten feet either way from the others, and this small difference is to be considered as of no importance in such a height, as it would seem like disputing about the thousandth of an inch in a man's measurement.

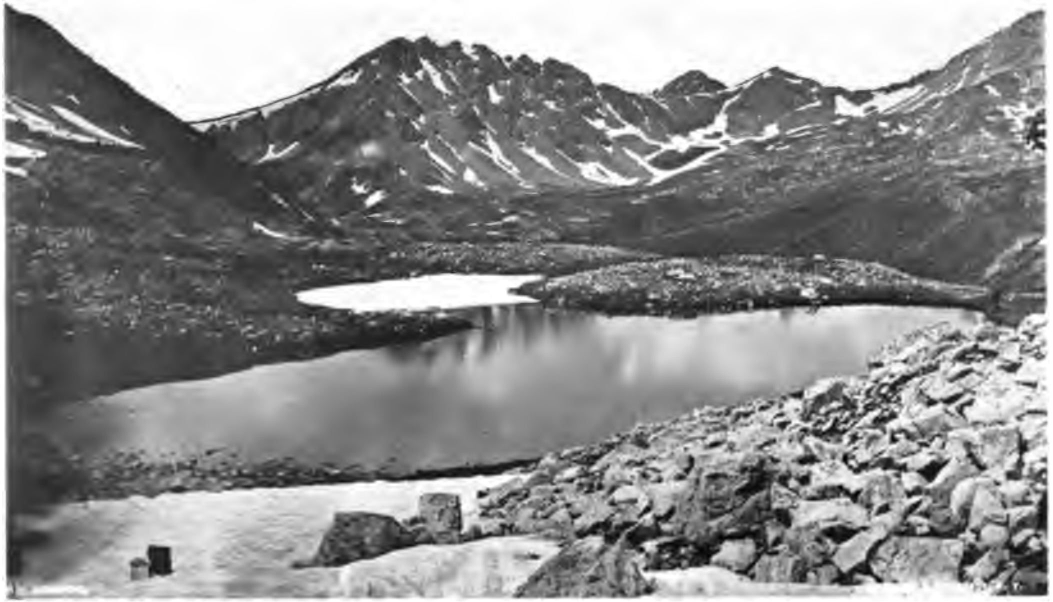
Where no base is mentioned in the above table, we used the place nearest the mountain that we wished to measure; obtaining its height by corresponding observation between it and some other place whose height was already known. For example, we obtained the height of our barometer in

Manitou by observations between it and the depot of the Rio Grande Railroad at Colorado Springs. The station in Manitou was in the Beebee House, in a room on the second floor on the rear of the building. In the height given, this difference is allowed for, and the elevation is that of the ground. The difference between our height and that of Dr. Hayden's may be due to the difference in the location chosen as the point to be measured, as this could easily be allowed for on such rough ground. In measuring Mts. Lincoln, Bross, Silverheels, and Quandary, we used Alma as a base, and obtained its height by a careful series of observations between it and a point the height of which was known, in Fairplay. For the measurement of Mt. Princeton, we used the height of Helena, as given by the surveys of the South Park Railroad. For the measurements of Mts. Gray and Evans, we took the height of the Clear Creek Railroad station at Georgetown as a basis, and measured the height up to our stationary barometer, which was in the Barton House. In the measurement of these last two mountains we compared the two mercurials and one aneroid very carefully, and left the aneroid below with an observer, Mr. Osborn, and took the others to the summits of the two mountains at the same time. It was our object to make simultaneous observations, in order to find out which of the two was the higher. In this we were successful, but were rather disappointed in the day being stormy, and thus not giving us as good an opportunity as we wished.

Our barometers were our constant companions, although we rode several hundred miles on horseback, and we usually carried in addition to them the rest of our instruments strapped to our bodies. We usually carried, besides the barometer, a pocket-sextant, aneroid, level, thermometer, clinometer and compass, and a telescope, together with our notebooks.

II.—UTAH.

Most of our barometric stations in our Utah measurements were also the stations of our triangles, and have therefore been already described in the topographical part of this



Western Slope of Continental divide,

Twin Lake Range.

report. Our barometers were always used in the same way as in Colorado, the same rules being followed in every case. We have reserved this matter, however, for the following section, where we intend to discuss the methods we made use of. It will be needless to repeat here the list of heights already given in the topographical report. The only peculiarity of our work in Utah was that the lower barometer was situated for most of the time in the centre of the valley of the East Branch of Smith's Fork.

Our usual method of procedure was, on reaching the top of the mountains, to lay the instruments on the ground and build a monument, which not only served as a point of reference for our transit, but as a support for the barometer. Then setting up the transit, and hanging the barometer by the side of the monument, we first made the transit observations, and then those of the barometer; thus, giving the barometer ample time to cool off and adjust itself, observations were then made on it, which lasted from half to three quarters of an hour. The mean of these was taken in the general calculations, but when greater care seemed to be needed, each observation was calculated separately.

We resorted to every expedient within our reach to make our work correct. We remeasured the peaks of whose measurements we were in any degree doubtful. When ascending one slope, if by means of our pocket-level we found we were on a level with a summit on the other, we measured the point on which we stood, and drew a sketch from it, which gave us a good contour line to follow.

Sketches were also made from the various peaks, which gave us the drainage of the valley, and of its neighboring ones, Black's and Henry's Forks. Our transit measurements were generally checked by the pocket-sextant, in what is known as a "tour d'horizon." We also made many measurements of the dip of the strata, where any importance was attached to them.

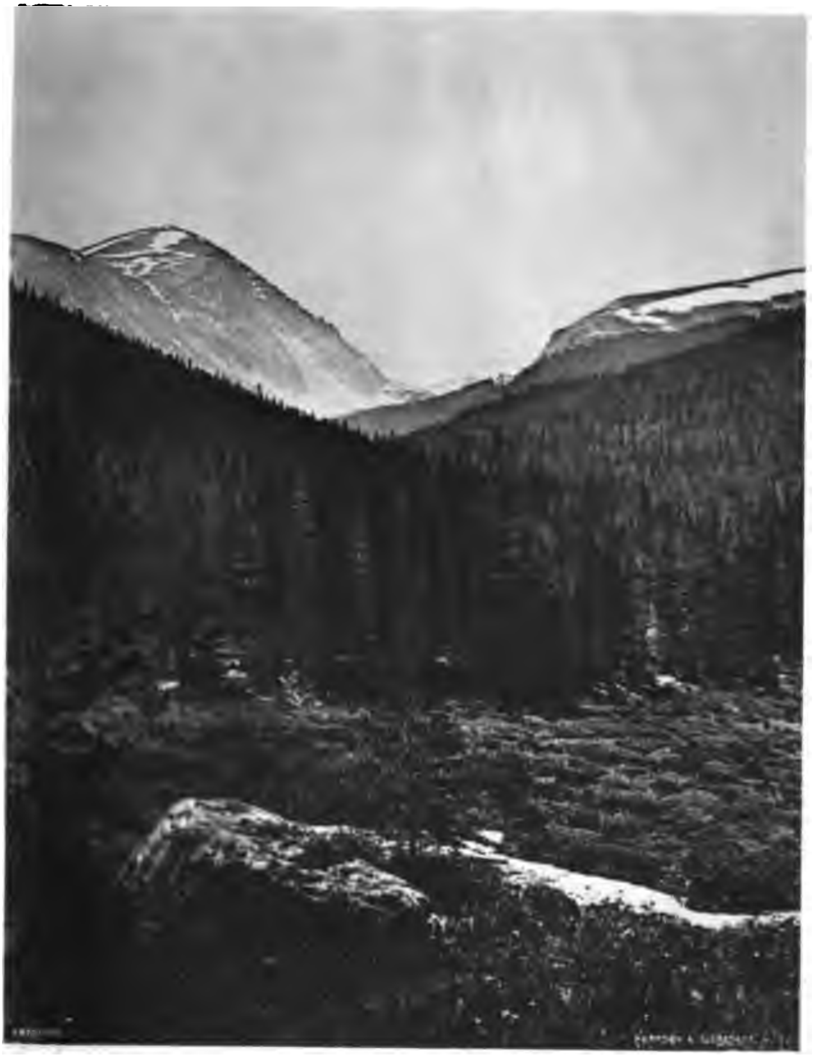
In addition to the instruments carried in Colorado, we had our transit with its tripod, and this made quite a load.

III.—BAROMETRIC WORK.

The barometers used were always carefully compared before and after each day's work, and a long comparison, lasting for three days, was made before and after our trip, which gave very good results, and proved the barometers worthy of confidence. There was a constant difference of ·002 of an inch, which was obtained from the observations made before we started. This was, at times, increased to ·004 of an inch, but never more.

We observed the usual elements for barometric measurements in the following order: date, time, temperature of the barometer, height of the barometric column, temperature of the air, and the general state of the atmosphere. The meteorological record will give the elements used in our corresponding observations. We also made it a point to expose our barometers to the free action of the atmosphere, but out of the direct rays of the sun, in the shade either of a monument, a house, or a tree. In all our measurements the lower barometer was brought as close as possible to the base of the mountain, in order to avoid any differences of pressure which might arise from the horizontal distance of the two instruments. For the same reason we preferred, when practicable, a position in a north and south line, in order to diminish the influence of barometric waves passing from west to east. The exact altitude of this lower station was always obtained (when we could not get the height from any reliable source) by a series of observations between it and some place the elevation of which could be relied upon. We were often helped in this by the consultation of the maps and surveys of railroads, to which we were given access in the most obliging way. The tables used in the calculation of the heights from the observations were the Hypsometrical Tables in the "Smithsonian Meteorological and Physical Tables," prepared by Dr. Guyot.

The influence of the time of the day at which the observations have been taken, an element too often neglected in barometrical measurements, has been corrected by means of a manuscript table by the same author. This table gives the corrections to be applied to the results obtained for each hour of the day, and each month of the year. These correc-



Blue River and Mountains, from

Hoosier Pass.

tions have been derived from the elaborate discussion by Prof. E. Plantamour of the long series of thermometrical and barometrical observations made at Geneva and the St. Bernard, as a means of ascertaining altitudes, in the "Mémoires de la Société de Physique de Genève." They are calculated for use in connection with the class of hypsometric tables founded upon the barometric formula of La Place, to which Dr. Guyot's tables belong.

The total correction thus applied for the influence of the hour of the day, contains two main corrections, one for the difference in amount and in time, above and below, in the daily tide of the barometer, the so-called *horary* (hourly) variation; and another, by far the largest, for the error in the true mean temperature and moisture of the layer of air between the upper and lower barometer, as given by the observation of the instruments at both stations. As the last depends upon conditions of the atmosphere extremely variable, which cannot be reduced to a formula, it is evident that the amount of the total correction has to be modified according to the various states of the atmosphere existing at the time of the observation. When the sky is clouded, or during a fog, and with a gentle wind mixing the layers of the atmosphere, the average temperature of the air, given by the arithmetical mean of the upper and lower thermometers, will be much nearer the true one than when the air is calm, the sky clear, and the insolation and radiation excessive. In the latter case the layers nearer the ground, in which the instruments are necessarily placed, show abnormal temperatures, which, according to the hour of the day at which they are taken, are either above or below the mean temperature of the whole mass of the air.

We have, therefore, somewhat modified the amount of the correction when it seemed advisable to do so, after a careful consideration of the atmospheric circumstances indicated in the accompanying meteorological record.

We feel confident that by this method, the greater part, if not the whole, of the influence of the hour of the day is corrected.

The elements of the corrections having been derived from observations made between 1000 and 9000 feet, it remains to be seen whether they are equally applicable to higher altitudes. This matter remains for future investigation. Thus far the results of our measurements up to nearly 14,400 feet seem to justify their use to an altitude of 15,000 feet.

We will now devote a little space to the aneroid barometers, and a few facts that were noticed concerning them during our stay in Colorado. The best one of these instruments was given to the Palæontologists when we reached Fort Bridger, and the other was left in our camp while we were in the mountains, and used but little.

They were taken more for the purpose of giving them a series of severe tests than for any work that we expected of them. One or the other of them was always carried to the top of each mountain we measured in Colorado, having been previously carefully set and compared with the mercurial barometers. In the measurement of the eight mountains upon which they were used they always acted in the same peculiar manner, seldom reaching their true height within half an hour of the time they were on the top; and on the return having as much hesitation about coming to a standstill.

There seem to be two great causes of such actions. The first and principal one is the unequal expansion and contraction of the metallic box upon which the measurements depend; the second of these causes is the mechanical work performed by the same box in the rotation of the index.

This last difficulty can be, and in fact has been, overcome in that form of aneroid made by Goldschmid, of Zurich; but the first cannot be as easily cured, as it seems to be a defect in the system employed. The metal having once been expanded can never return to the same condition, a change having probably taken place in the situation of its molecular components.

We give the following as examples of this action of the aneroids; they are a fair sample of the rest, and not exaggerated ones:

Pike's Peak, July 5th, 1877.—Barometer 2233, at Lake House, two feet above the ground.

TIME.	T.	B.	t.	Aneroid.	REMARKS.
A.M.					
5.40	58.2	21.014	59.0	21.38	*Fair and warm.*
5.50	60.5	21.014	59.9	21.39	*Clouds 1. cirrus.*
5.60	61.6	21.016	60.0	21.39	*Wind N. W. 1.*

Pike's Peak, July 5th, 1877.—*Barometer* 2233, *on the outside of the house of the Signal Service. Two feet six inches below the highest point of the mountain.*

TIME.	T.	B.	t.	Aneroid.	REMARKS.
A.M.					
9.45	53.6	18.250	49.1	18.85	*Fair and warm.*
9.50	52.8	18.252	48.4	18.83	*Clouds* 4, *cirro cumulus.*
9.55	54.3	18.250	49.1	18.85	*Wind S. E.* 1.
10.00	52.3	18.250	47.3	18.85	
10.05	50.3	18.248	48.1	18.85	
10.10	51.6	18.248	48.3	18.89	
10.15	50.6	18.250	47.1	18.83	

This table also gives the form in which our observations were taken and kept.

These facts lead us to infer that, though the aneroid may answer very well for the comparatively small heights of our Eastern coasts, it will hardly do for such great elevations, or for such long distances as are found in the West. It needs constant watching and correcting by comparisons with a mercurial barometer, as its zero point is apt to change by the handling of the instrument. The influence of the temperature, even in those which bear on their face "*compensated,*" is by no means eliminated, and a correction has to be found experimentally for each instrument. It also needs (an idea which few persons having an aneroid seem to realize) considerable care in transportation, and an accident to it is wholly beyond the possibility of repair in the field, while a mercurial barometer, with the aid of a little ingenuity, can be readily repaired, if pains have been taken to carry the requisite duplicate parts along with the instrument.

METEOROLOGICAL REPORT.

UTAH.

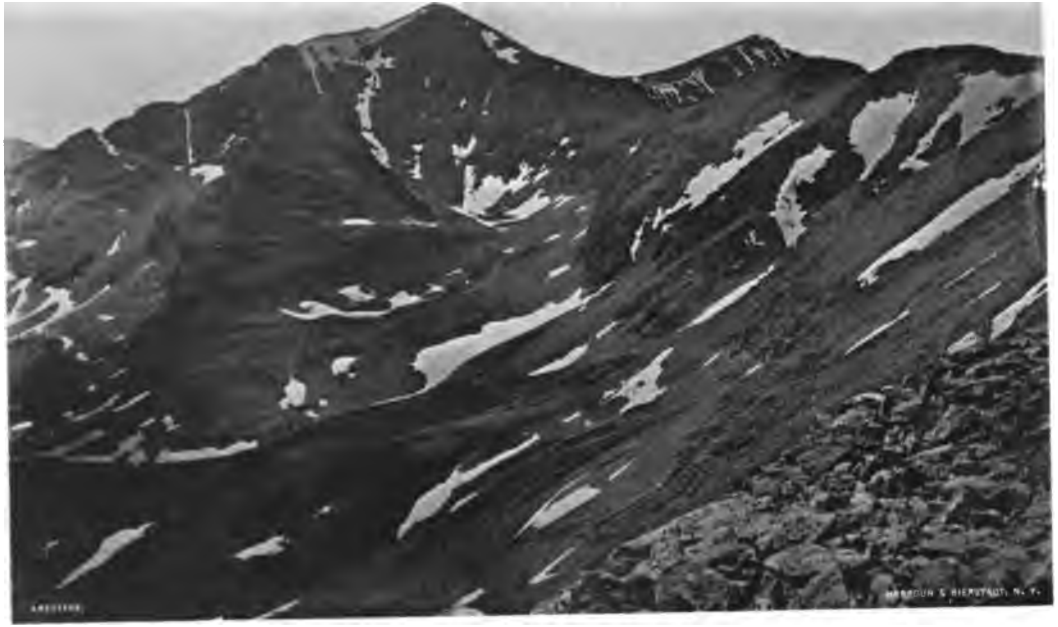
ARTOTYPE. HARROUN & BIERSTADT, N.Y.

Mt. Lincoln and the Head Waters
of the Platte.

METEOROLOGICAL REPORT.

THE six weeks which were spent in the mountain valley of Smith's Fork were marked by great variations of temperature, and many curious phenomena, both in atmospheric and magnetic changes, which were very noteworthy. We were somewhat sheltered in our camp from the violence of the storms which swept over the mountains above us, but at the last part of our stay we had the only alternative of working early in the morning and on till eleven o'clock A.M., or doing no work at all. When it is also remembered that a height of 3000 feet had to be climbed from our camp before our real day's work began, and that, even then, we were not at all sure that we would not be driven out by electric storms at any moment, some of the difficulties of our work may be appreciated. The storms, usually of snow or hail, set in on the mountains at eleven and continued until late in the afternoon, during which time it was almost an impossibility to go near the top of the ridge without the most painful sensations caused by electricity. While the hailstorms lasted (and they were frequent) those who were on the ridge had to seek shelter under the ledges to avoid the hard blows from globes of ice often reaching from one half to three quarters of an inch in diameter. We were finally driven from the mountains by these storms, as they reduced our working hours to a minimum; and we had to return to Fort Bridger. The meteorological record, though a mere record of the state of the atmosphere for a few days at a time, gives, nevertheless, on a close examination, some very interesting facts in regard to the curious action of the air; but it can be of no great value otherwise. The observations were taken every fifteen minutes during the days in which they were kept, and were made with more special reference to the corresponding observations of the barometer, in order to obtain the full account of the circumstances under which we were working, than for a regular and systematic meteorological record. The tables explain themselves, giving in separate columns the various necessary elements, viz.: Date, time, temperature, barometer observed, barometer reduced to the freezing point, wet and dry bulb thermometers, their difference and the relative humidity derived from it, the wind's direction and force, the cloudiness and the nature of the clouds, with some remarks on the state of the weather.

The storms which we encountered were without doubt the result of the overheating of those large and elevated plateaus, the inclined sides of which, as well as the mountain slopes, expose a larger surface to the rays of the sun than would a merely flat body. These circumstances would seem to help the formation of strong ascending currents, which, having once been started, furnish ample material for the midday showers. These storms gradually extend their limits, as to time, until the rainy season is complete. They seemed to be similar to those of tropical regions, and this fact enabled us to explain the presence of such large quantities of electricity in the air. Once only, during our stay, did we observe two different layers of clouds, one above the other, moving in opposite directions. Their line of motion was almost due N. E. and S. W., the upper one moving S. W. This was seen from the cliff on which No. 9 is situated, and was watched as a great curiosity, as one cloud was almost on a level with us, and the other some distance above. We were now and then favored with beautiful rainbows, on two occasions seeing triple arcs, and a single one was the exception rather than the rule. The temperature during the first part of our stay was quite favorable to our work, being just cool enough for the exercise of brisk walking during the day; but at night generally freezing the edges of the brook near our camp, or any water left out in small vessels, thus making a number of blankets very necessary articles for our comfort; and a blazing camp-fire of pine stumps not only a pleasure to the eyes, but to the fingers also. Before the end of our stay (our camp was at a height of 10,500 feet), we needed all our heavy clothing and generally a fire all day as well as at night.



HARROUN & BIERSTADT, N. Y.

Greys Peak, from Argentine Pass.

The electricity spoken of above was very troublesome, rendering the needle of the transit almost useless, and running in a stream at times from the end of the barometer to the ground. We received a great number of shocks when using the instruments. The discharge seemed to come from above us, but was not always accompanied by strokes of lightning. We found that the simple practice of lifting the hand above the head with one finger elevated served to relieve the unpleasant sensation of buzzing behind the ears, and, when once more it became unbearable, by lifting another finger we made the body a sort of doubled Leyden jar. The delay thus obtained enabled us to pack the instruments with the other hand and to get away from the monument. In one instance the monument (ill-fated No. 18, which was only just built) was torn into fragments by lightning while we were but a short distance off.* We sometimes found the wind very troublesome while making observations with the transit, as it blew with terrific force over the exposed summits of the peaks. We were, however, very much pleased with the invigorating air of the place, and when it was clear we could not have wished for greater enjoyment in out-door life than we found there.

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* U. S. Geol. and Geog. Survey, 1874, p. 456, etc.

Barometer 2219, *at Station in Camp Nassau.* (3.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D –	R. H.	Wind, direction and force (1 – 10).	Clouds (1 – 10).	Nature of clouds.	REMARKS.
Thursday, August 9th, 1877.	8.30	68·4	20·654	+·582	64·1	43·7	20·4	38·1	N. E. 2	0	.....	Fair ; warm.
	9.	70·1	20·656	+·580	66·2	46·1	20·1	40·2	E. 2	0	......	“ “
	9.30	71·8	20·656	+·576	67·6	45·5	22·1	1·6	S. E. 2	0	.....	“ “
	10.	70·5	20·656	+·580	65·9	44·7	21·2	2·0	E. 2	0	... ..	“ “
	10.15	70·3	20·657	+·581	67·4	46·3	21·1	5·2	E. 2	0	......	“ “
	10.30	70·3	20·656	+·580	66·7	46·7	20·0	40·2	E. 1	0	......	“ “
	10.45	70·6	20·658	+·582	68·8	47·5	21·3	6·8	E. 1	1	Cirrus.	“ “
	11.	71·3	20·658	+·580	68·4	47·5	20·9	39·9	N. E. 3	1	“	“ “
	11.15	69·5	20·657	+·583	66·3	45·8	20·5	39·7	N. E. 2	2	Cirro-cumulus.	“ “
	11.30	69·7	20·656	+·582	66·4	46·4	20·0	40·2	E. 2	2	“ “	“ “
	11.45	69·8	20·655	+·581	66·5	47·5	19·0	42·7	E. 2	3	“ “	“ “
	12.	9·6	20·651	+·577	67·9	47·1	20·8	40·7	E. 1	4	“ “	Very warm.
	P.M.											
	12.15	71·7	20·651	+·573	68·5	47·7	20·2	40·7	E. 1	4	“ “	Warm.
	12.30	72·3	20·651	+·571	66·7	47·3	19·4	42·7	S. E. 2	5	“ “	“
	12.45	72·3	20·649	+·569	67·8	48·2	19·6	43·2	S. E. 2	6	“ “	“
	1.	74·1	20·649	+·566	67·8	47·6	20·2	40·7	S. E. 3	6	“ “	“
	1.15	73·2	20·649	+·568	68·8	48·6	20·2	41·3	....	...	......	....
	1.30	76.6	20·650	+·563	70·5	50·2	20·3	42·3	E. 3	6	Cumulus.	“
	1.45	77·4	20·654	+·567	69·3	53·6	16·7	27·0	N. E. 3	7	“	“
	2.	72·2	20·648	+·570	69·3	51·7	17·6	21·8	N. E. 3	7	“	“
	2.15	70·1	20·640	+·564	61·4	49·5	11·9	37·2	E. 2	8	“	“
	2.30	67·7	20·635	+·564	65·3	49·7	15·6	23·6	N. E. 4	8	“	“ but pleasant.
	2.45	69·4	20·633	+·559	66·3	49·7	16·6	20·7	N. E. 4	8	“	“ “ “
	3.	67·8	20·632	+·561	66·2	47·8	18·4	13·8	N. E. 4	8	“	“ “ “
	3.15	67·9	20·628	+·557	65·5	48·8	16·7	19·3	N. E. 4	6	“	“ “ “
	3.30	66·3	20·625	+·556	62·4	47·6	14·8	24·0	E. 2	7	“	“ “ “
	3.45	67·3	20·623	+·552	65·2	50·1	15·1	26·4	S. E. 2	7	Cirro-cumulus.	“ “ “
	4.	66·7	20·622	+·553	64·6	47·6	14·0	25·7	S. E. 3	7	“ “	Cooler.
	4.15	66·1	20·619	+·550	64·2	49·0	15·2	25·1	S. E. 3	7	“ “	“
	4.30	65·9	20·620	+·553	63·9	49·0	14·9	26·7	S. E. 3	7	“ “	Thunder in S. E.
	4.45	64·6	20·617	+·552	62·8	47·5	15·3	22·4	S. E. 3	7	“ “	Cool.
	5.	65·8	20·617	+·550	63·8	47·6	16·2	19·3	S. E. 2	7	“ “	“
	5.30	65·2	20·616	+·549	63·3	47·8	15·5	20·8	S. E. 1	6	Cumulus.	“
	6.	63·0	20·616	+·554	62.5	47·0	15·5	20·8	S. W. 1	7	“	“
	6.30	61·7	20·610	+·552	59·9	46·5	13·4	28·1	S. 1	6	Cirro-cumulus.	“
	7.	55·3	20·612	+·563	54·9	45·2	9·7	41·1	S. E. 1	5	“ “	“

T. = Attached thermometer. B. = Barometer observed. 32° B = Reduced to freezing-point. D. B. = Dry bulb thermometer. W. B. = Wet bulb thermometer. D – = Difference between dry and wet thermometer. R. H. = Relative humidity.

Barometer 2219, *at Station in Camp Nassau.* (3.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D –	R. H.	Wind, direction and force (1 – 10).	Clouds (1 – 10).	Nature of clouds.	REMARKS.
Friday, August 10th, 1877.	9.	67·8	20·689	+·618	63·4	48·2	15·2	23·8	S. 1	2	Cirrus.	Fair now, but heavy clouds [earlier.
	9.30	68·6	20·691	+·619	65·6	50·2	15·4	26·4	S. E. 2	4	Cirro-cumulus.	Cooler.
	10.	67·8	20·692	+·621	62·4	48·7	13·7	28·8	S. E. 2	4	" "	Cool.
	10.15	65·8	20·692	+·625	61·0	47·6	13·4	29·3	S. 2	6	" "	"
	10.30	63·5	20·684	+·621	60·5	48·1	12·4	34·2	S. 3	8	Cumulus.	" and breezy.
	10.45	68·8	20·692	+·620	64·6	48·8	15·8	23·8	S. 3	8	"	"
	11.	68·9	20·694	+·622	64·9	49·3	15·6	23·6	S. 2	8	"	"
	11.15	65·2	20·690	+·623	60·2	47·1	13·1	29·3	S. 2	8	"	"
	11.30	60·4	20·683	+·625	57·8	46·4	11·4	35·8	S. 2	5	"	" (Rain).
	11.45	62·1	20·680	+·619	60·5	47·5	13·0	29·3	S. 3	7	Cirro-cumulus.	Warm.
	12.	68·8	20·688	+·616	65·1	51·7	13·4	34·0	S. 3	7	" "	"
	P.M.											
	12.15	69·9	20·690	+·616	63·4	47·9	15·5	22·4	S. E. 3	8	" "	"
	12.30	67·9	20·689	+·618	63·6	49·9	13·7	31·7	S. 3	8	" "	"
	12.45	72·6	20·694	+·614	67·8	50·5	17·3	20·6	S. 3	8	" "	"
	1.	69·4	20·694	+·620	64·4	49·2	15·2	25·1	S. 2	8	Cumulus.	"
	1.15	70·1	20·694	+·618	64·1	50·3	13·8	32·9	S. W. 3	7	Cirro-cumulus.	"
	1.30	67·5	20 688	+·617	62·4	48·7	13·7	30·6	S. W. 3	8	" "	Cooler.
	1.45	64·6	20·684	+·619	61·5	48·4	13·1	30·6	W. 3	8	" "	"
	2.	61·9	20·683	+·623	58·8	46·9	11·9	36·1	W. 4	9	" "	Breezy.
	2.15	61·7	20·681	+·621	58·2	46·3	11·9	33·8	W. 4	9	Cumulus.	Quite cool.
	2.30	60·4	20·681	+·623	58·3	46·9	11·4	35·8	W. 3	9	"	" "
	2.45	58·4	20·681	+·627	56·1	45·3	10·8	36·7	S. W. 4	9	"	" "
	3.	58·5	20·682	+·628	56·4	45·8	10·6	36·7	S. W. 4	9	"	" "
	3.15	58·2	20·682	+·628	55·4	45·1	10·3	38·8	S. W. 3	9	Cumulus nimbus.	" "
	3.30	63·4	20·679	+·616	61·7	48·8	12·9	32·4	S. W. 3	4	Cirro-cumulus.	" "
	3.45	65·7	20·680	+·613	61·6	49·6	12·0	35·3	S. 2	3	" "	Pleasant.
	4.	62·4	20·678	+·617	60·3	48·9	11·4	38·1	S. 2	6	" "	"
	4.15	62·2	20·674	+·613	60·3	49·2	11·1	39·2	S. W. 2	7	" "	"
	4.30	61·7	20·670	+·610	59·8	48·7	11·1	38·1	W. 3	8	" "	"
	4.45	60·6	20·667	+·609	58·7	47·1	11·6	37·0	S. W. 2	3	" "	"
	5.	60·4	20·665	+·607	58·6	47·6	11·0	37·0	S. 1	5	" "	Cool.
	5.30	58·8	20·664	+·610	57·8	46·2	11·6	33·8	S. 1	2	" "	Pleasant.
	6.	56·8	20·664	+·614	56·0	45·9	10·1	38·8	S. 2	2	" "	"
	6.30	54·4	20·664	+·617	54·2	45·4	8·8	45·8	E. 1	1	" "	Cool.
	7.	53·3	20·664	+·619	53·4	45·3	8·1	48·3	....	3	Cirrus.	"

Barometer 2219, at Station in Camp Nassau. (3.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D −	R. H.	Wind, direction and force (1 − 10).	Clouds (1 − 10).	Nature of clouds.	REMARKS.
Saturday, August 11th, 1877.	9.	61·2	20·724	+·663	57·0	49·0	8·0	52·1	E. 2	8	Cumulus.	Cool.
	9.15	61·0	20·718	+·657	59·0	49·0	10·0	43·2	E. 2	8	“	“
	9 30	58·8	20·718	+·662	56·0	48·5	7·5	53·6	....	9	“	Few rain-drops.
	9.45	58·0	20·716	+·662	55·2	47·0	8·2	50·2	N. E. 2	9	“	“ “ “
	10.	55·0	20·716	+·667	53·6	45·5	8·1	48·3	N. W. 3	9	“	Light shower.
	10.15	55·0	20·716	+·667	53·2	46·0	7·2	54·4	N. W. 4	9	“	Cool and threatening shower.
	10.30	55·5	20·718	+·668	53·0	45·8	7·2	53·5	W. 3	9	“	“ “ “ “
	10.45	55·0	20·716	+·667	53·8	46·0	7·8	51·8	Calm.	9	“	“ “ thunder in the dis-
	11.	55·0	20·716	+·667	53·0	47·0	6·0	60·6	“	9	“	“ “ “ “ [tance.
	11.15	54·5	20·714	+·666	53·0	45·2	7·8	50·8	“	9	“	“ “ showers S. W.
	11.30	55·5	20·714	+·664	53·2	47·0	6·2	60·6	“	9	“	Clearing in W.
	11.45	57·0	20·714	+·667	55·0	47·5	7·5	52·7	“	8	“	“ “
	12.	56·0	20·714	+·663	54·5	45·0	9·5	41·1	W. 2	8	“	Rain E.
	P.M.											
	12.15	55·0	20·712	+·663	54·0	45·0	9·0	43·4	W. 2	8	“	“ “
	12.30	54·5	20·710	+·662	54·0	45·2	8·8	45·8	W. by S. 3	8	“	Cloudy in W.
	12.45	54·0	20·708	+·661	52·5	45·0	7·5	50·8	“	8	“	“ “
	1.	54·5	20·706	+·658	53·5	46·0	7·5	51·8	W. 2	8	“	“ “
	1.15	54·5	20·706	+·658	53·2	45·2	8·0	48·3	W. 2	9	Stratus.	“ “
	1.30	53·5	20·706	+·660	52·0	45·2	6·8	56·2	Calm.	9	“	“ “
	1.45	53·0	20·704	+·659	54·0	46·0	8·0	49·3	“	9	“	“ and cool
	2.	53·0	20·702	+·657	52·0	44·2	7·8	49·8	“	10	“	Rain.
	2.15	53·4	20·700	+·653	51·8	43·8	8·0	46·1	“	8	“	Clearing in W
	2.30	56·6	20·698	+·647	54·5	45·0	9·5	41·1	W. 3	8	“	“ “
	2.45	55·8	20·694	+·644	54·6	44·8	9·8	39·9	S. W. 4	6	Cumulus and str.	“ “
	3.	57·5	20·690	+·636	55·0	46·4	8·6	46·9	S. W. 3	6	“ “ “	“ “
	3.15	56·6	20·688	+·636	54·2	45·2	9·0	43·4	S. W. 3	6	“ “ “	“ “
	3.30	57·2	20·686	+·632	54·8	46·2	8·6	46·9	S. W. 4	8	“ “ “	Cool.
	3.45	55·8	20·682	+·632	54·5	45·6	8·9	45·8	S. W. 2	9	Cumulus	Cloudy and cool.
	4.	52·8	20·682	+·637	50·0	45·0	5·0	64·6	S. W. 4	9	“ and str.	Threatening and cool.
	4.15	52·5	20·682	+·637	50·0	45·2	4·8	67·6	S. W. 3	9	“ “ “	“ “ “
	4.30	50·8	20·684	+·643	49·2	44·0	5·2	63·8	S. W. 2	9	“ “ “	“ ‘
	4.45	50·0	20·688	+·649	49·5	45·0	4·5	67·0	S. W. 2	10	“ “ “	Rain, light.
	5.	50·8	20·688	+·647	49·6	45·0	4·6	67·0	S. W. 3	10	“ “ “	“ “
	5.30	....	......	......	47·0	44·2	2·8	80·7	N. 2	10	“ “ “	“ “
	6.	....	......	......	44·5	44·0	·5	63·8	S. W. 2	8	“ “ “	“ “

Barometer 2219, *at Station in Camp Nassau.* (4.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D –	R. H.	Wind, direction and force (1 – 10).	Clouds (1 – 10).	Nature of clouds.	REMARKS.
Tuesday, August 14th, 1877.	9.	57·8	20·700	+·648	56·4	46·9	9·5	42·2	N. W. 2	3	Cumulus.	Fair, warm.
	9.30	59·4	20·700	+·644	56·3	46·5	9·8	42·2	N. W. 3	5	“	“ pleasant breeze.
	10.	56·8	20·700	+·650	53·8	45·3	8·5	45·8	N. W. 3	8	“	Clouded over, cool.
	10.15	55·8	20·697	+·648	54·4	45·6	8·8	45·8	W. 3	9	“	“ “ “
	10·30	59·8	20·701	+·645	56·7	46·2	10·5	37·9	W. 4	9	“	“ “ “
	10.45	57·7	20·700	+·648	55·2	45·1	10·1	38·8	W. 5	9	“ nimbus.	“ “ “
	11.	58·4	20·700	+·646	55·4	45·6	9·8	41·1	W. 3	8	“ “	“ “ “
	11.15	59·6	20·700	+·644	55·7	46·1	9·6	42·2	S. W. 3	7	“ “	Rain, clouded over, cool.
	11.30	59·5	20·698	+·642	56·8	46·5	10·3	39·9	S. W. 3	7	“ “	Hail storm, 10 minutes.
	11.45	58·4	20·697	+·643	58·8	48·3	10·5	40·1	S. W. 3	6	“ “	Pleasant.
	12.	60·5	20·700	+·642	60·4	47·7	12·7	31·2	W. 2	4	“ “	“
	P.M.											
	12.15	61·3	20·700	+·640	59·5	46·5	13·0	28·1	W. 3	4	“ “	“
	12.30	63·3	20·700	+·633	59·8	47·7	12·1	33·0	N. W. 3	6	“ “	“
	12.45	63·4	20·701	+·634	60·2	47·3	12·9	31·2	N. 2	6	“ “	“
	1.	58·2	29·699	+·645	56·4	45·3	11·1	34·6	N. 3	5	“ “	“
	1.15	59·6	20·700	+·644	57·7	46·2	11·5	33·8	N. 5	2	“ “	“
	1.30	60·8	20·700	+·642	59·1	46·7	11·4	35·8	N. W. 4	1	“ stratus.	“
	1.45	61·1	20·697	+·637	59·4	46·4	13·0	28·1	N. W. 3	2	“ “	“
	2.	62·2	20·698	+·637	60·8	48·3	12·5	32·4	W. 2	3	“	“
	2·15	61·6	20·697	+·637	57·8	45·2	12·6	28·6	W. 3	7	“ nimbus.	Clouding over, fast.
	2.30	57·7	20·692	+·640	56·2	44·6	11·6	31·2	W. 3	9	“ “	Cool.
	2.45	57·8	20·693	+·641	56·4	44·4	12·0	29·2	W. 4	9	“ “	“
	3·	63·4	20·694	+·631	56·6	44·9	11·1	31·2	N. W. 3	3	“	“
	3·15	58·8	20·691	+·637	58·4	45·3	13·1	26·7	N. W. 3	3	“	“
	3·30	57·0	20·689	+·637	55·3	44·1	11·2	33·3	N. W. 3	5	“	“
	3 45	59·4	20·685	+·629	58·3	45·8	12·5	28·6	N. W. 3	3	“	“
	4·	61·3	20·682	+·622	59·7	45·4	14·3	22·9	N. W. 3	5	“	Warm, sun out.
	4·15	59·3	20·680	+·624	57·0	43·4	13·6	22·0	W. 3	5	“	Cool again.
	4·30	59·1	20·680	+·624	57·6	43·2	14·4	20·1	W. 3	4	“	“
	4·45	58·8	20·679	+·625	57·0	43·1	13·9	22·0	W. 3	5	“	“
	5·	56·4	20·679	+·629	55·3	42·6	12·7	24·3	W. 3	7	“	“
	5·30	56·8	20·679	+·629	55·4	42·4	13·0	22·4	W. 4	6	“	“
	6.	55·2	20·678	+·629	54·6	42·3	12·3	26·4	W. 2	2	“ stratus.	Pleasant.
	6·30	54·1	20·677	+·630	52·7	42·3	10·4	35·0	W. 1	2	Stratus.	“
	7·	49·8	20·676	+·638	49·2	41·4	7·8	46·6	S. 1	4	“	“

Barometer 2219, *at Station in Camp Nassau.* (4.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D −	R. H.	Wind, direction and force (1 − 10).	Clouds (1 − 10).	Nature of clouds.	REMARKS.
Wednesday, August 15th, 1877.	9.45	60·0	20·686	+·628	58·8	45·1	13·7	24·9	N. by W. 2	3	Cumulus.	Pleasant.
	10.	63·2	20·688	+·623	60·5	46·6	13·9	26·3	N. by W. 3	4	"	"
	10.15	62·8	20·688	+·624	58·8	45·2	13·6	24·9	N. by W. 3	5	" and nimbus.	"
	10.30	59·2	20·690	+·632	57·0	44·1	12·9	27·2	S. W. 2	6	"	Cloudy.
	10.45	57·0	20·690	+·636	55·8	44·5	11·3	33·3	W. 2	7	"	Little rain.
	11.	62·8	20·692	+·628	60·5	47·6	12·9	31·2	W. 3	5	"	Clear.
	11.15	61·8	20·694	+·633	58·8	45·6	13·2	26·7	W. 3	5	"	"
	11.30	60·2	20·694	+·632	60·0	47·0	13·0	29·3	N. by W. 3	5	"	" and rain in E.
	11.45	60·2	20·694	+·636	60·4	47·0	13·4	29·3	N. by W. 3	5	"	" in E.
	12.	60·5	20·694	+·636	58·0	45·5	12·5	28·6	W. 3	6	"	"
	P.M.											
	12.15	62·8	20·694	+·630	61·5	47·0	14·5	24·0	W. 5	5	"	Showers in E.
	12.30	63·0	20·696	+·632	60·2	45·0	15·2	19·6	W. 4	5	"	" "
	12.45	58·8	20·692	+·636	55·5	43·4	12·1	27·8	N. W. 3	7	"	Little rain.
	1.	62·8	20·690	+·627	61·4	46·5	14·9	22·7	W. 4	7	"	Clear.
	1.15	65·0	20·690	+·623	63·8	43·5	20·3	2·6	W. 3	6	"	"
	1.30	66·2	20·688	+·619	63·5	44·6	18·9	7·9	W. 4	6	"	"
	1.45	61·5	20·688	+·627	60·5	45·2	15·3	19·6	W. 3	5	"	"
	2.	60·8	20·688	+·628	58·8	44·5	14·3	21·5	W. 4	6	"	Cloudy.
	2.15	60·5	20·686	+·626	59·8	45·8	14·0	22·9	W. 5	6	"	Clear.
	2.30	63·0	20·684	+·621	61·5	45·6	15·9	18·0	W. 6	6	"	"
	2.45	61·5	20·682	+·621	59·0	46·2	12·8	30·0	W. 3	5	"	"
	3.	62·0	20·680	+·618	60·5	46·0	14·5	22·7	W. 4	4	"	"
	3.15	62·0	20·678	+·616	61·0	44·8	16·2	15·0	W. 3	4	"	Cloudy.
	3.30	61·8	20·678	+·616	60·6	45·5	15·1	19·6	W. 3	5	"	"
	3.45	61·5	20·678	+·616	59·6	45·0	14·6	21·2	W. 4	4	"	"
	4.	59·0	20·674	+·618	57·8	44·0	13·8	23·5	W. 3	3	"	Clear.
	4.15	60·5	20·672	+·613	59·0	43·8	15·2	16·6	W. 4	5	"	"
	4.30	58·2	20·670	+·616	57·8	43·2	14·6	18·3	W. 3	5	"	Cloudy and cool.
	4.45	60·5	20·670	+·612	61·0	46·8	14·2	24·3	W. 3	4	"	Clear.
	5.	62·5	20·668	+·607	61·6	45·0	16·6	15·0	W. 4	4	"	"
	5.30	60·0	20·668	+·610	59·3	44·8	14·5	19·8	W. 3	2	"	"
	6.	58·5	20·668	+·614	57·0	44·5	12·5	27·2	W. 2	2	"	"
	6.30	52·8	20·662	+·619	50·5	42·5	8·0	45·0	....	2	"	"
	7.	48·6	20·654	+·618	48·3	40·1	8·2	42·6	W. 1	1	Stratus.	"

Barometer 2219, *at Station in Camp Nassau.* (4.)

Date.	A.M.	T.	B.	32° B.	D. B.	W. B.	D –	R. H.	Wind, direction and force (1 – 10).	Clouds (1 – 10).	Nature of clouds.	Remarks.
Thursday, August 16th, 1877.	9.	59·8	20·694	+·638	56·5	46·5	10·0	39·9	W. 1	8	Cumulus stratus.	Cool ; cloudy.
	9.30	61·3	20·696	+·636	59·2	48·2	11·0	38·1	W. 2	7	“ “	“ “
	10.	60·2	20·699	+·641	57·6	46·3	11·3	35·8	W. 3	10	“ nimbus.	“ “
	10.15	59·5	20·699	+·643	57·7	46·7	11·0	35·8	W. 3	6	“ “	“ “
	10.30	62·3	20·699	+·638	59·9	46·4	13·5	26·3	W. 1	6	“ “	“ “
	10.45	62·3	20·697	+·636	60·2	47·3	12·9	31·2	W. 1	8	Cumulus.	“ “
	11.	63·6	20·698	+·635	61·6	42·4	19·2	3·3	W. 3	9	“ nimbus.	“ “
	11.15	58·4	20·697	+·643	56·3	44·6	11·7	31·2	W. 2	10	Nimbus.	Slight rain.
	11.30	57·0	20·695	+·643	55·4	44·9	10·5	35·4	W. 1	10	“	Cool ; cloudy.
	11.45	58·6	20·694	+·640	56·9	46·8	10·1	39·9	W. 1	10	“	“ “
	12.	60·5	20·694	+·636	57·0	46·6	10·4	39·9	W. 3	10	“	“ “
	P.M.											
	12.15	56·0	20·693	+·643	53·9	45·8	8·1	48·3	W. 2	10	“	“ “
	12.30	57·5	20·693	+·641	52·8	45·6	7·2	53·5	W. 1	10	“	“ “
	12.45	59·0	20·692	+·636	52·4	45·4	7·0	53·5	W. 1	10	“	“ “
	1.	50·6	20·687	+·648	49·3	44·0	5·3	63·8	W. 2	10	“	Rain.*
	1.15	47·3	20·683	+·649	47·2	43·4	3·8	73·2	W. 3	10	“	“ and wind,
	1.30	48·6	20·683	+·647	48·3	45·0	3·3	77·7	W. 6	10	“	“ “
	1.45	49·0	20·683	+·645	49·2	46·1	3·1	78·1	N. W. 7	10	“	Rain.
	2.	No observations ; wind, rain, and smoke drove me out.										
	2.15	“ “ “ “ “ “ “ “ “										
	2.30	58·0	20·683	+·628	53·0	46·2	6·8	57·0	N. 6	10	“	Cold.
	2.45	59·6	20·683	+·627	54·5	47·5	7·0	55·2	W. 2	10	“	Cold ; rain.†
	3.	54·0	20·698	+·631	51·4	45·1	6·3	59·0	N. W. 4	10	“	“ “
	3.15	49·4	20·696	+·658	48·6	43·7	4·9	66·3	N. 5	10	“	“ “
	3.30	50·5	20·695	+·656	48·5	43·7	4·8	66·3	N. 6	10	“	“
	3.45	47·8	20·685	+·651	46·2	43·3	2·8	80·3	N. W. 5	10	“	“ rain.
	4.	47·9	20·684	+·650	49·0	44·5	4·5	67·0	N. W. 3	10	“	“ “
	4.15	51·9	20·683	+·642	49·8	47·5	2·3	85·3	N. W. 2	7	Cumulus nimbus.	Clearing.
	4.30	53·2	20·680	+·635	51·4	46·8	4·6	68·3	S. 2	5	“ stratus.	“
	4.45	54·6	20·679	+·632	52·3	46·1	6·2	59·8	S. E. 2	4	“ “	“ cold.
	5.	53·4	20·676	+·631	51·5	45·5	6·0	59·0	E. 2	8	Cumulus.	Cool.
	5.30	49·2	20·672	+·634	52·8	46·9	5·9	62·6	E. 1	7	“	“
	6.	49·2	20·664	+·626	50·3	44·3	5·8	61·1	S. E. 1	7	“	“
	6.30	49·3	20·657	+·619	48·5	43·9	4·6	66·3	S. E. 1	7	“ stratus.	“
	7.	48·8	20·660	+·622	48·7	42·9	5·8	59·4	S. E. 1	9	“	“

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* Took barometer into tent, two feet below station.

† Barometer out again.

Barometer 2219, *at Station in Camp Nassau.* (4.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D –	R. H.	Wind, direction and force (1 – 10).	Clouds (1 – 10).	Nature of clouds.	REMARKS.
Friday, August 17th, 1877.	10.45	66·5	20·710	+·639	63·5	48·5	15·0	23·8	W. 3	5	Cumulus.	Clear and warm.
	11.	67·5	20·708	+·636	65·2	47·8	17·4	16·5	W. 4	6	" and stratus.	" " "
	11.15	67·5	20·708	+·636	64·0	48·5	15·5	22·2	N. W. 5	6	" "	" " "
	11.30	65·8	20·708	+·639	63·0	49·0	14·0	28·3	N. W. 4	6	" "	" " "
	11.45	66·0	20·708	+·638	62·5	47·8	14·7	24·0	N. W. 5	6	" "	" " "
	12.	61·5	20·706	+·645	59·6	47·5	12·1	33·0	N. W. 5	6	" "	"
	P.M.											
	12.15	60·5	20·702	+·642	58·0	47·5	10·5	39·0	N. W. 6	7	" "	Cloudy in W.*
	12.30	59·2	20·698	+·642	57·8	47·0	10·8	39·0	N. W. 5	7	" "	Cloudy; rain E.
	12.45	58·5	20·696	+·640	57·0	48·2	8·8	48·8	N. W. 3	8	" and nimbus.	" "
	1.	57·0	20·692	+·639	55·0	46·5	8·5	46·9	S. E. 4	9	" "	Shower.
	1.15	48·8	20·692	+·654	45·0	45·5	·5	96·0	S. E. 2	10	" "	Rain and hail.
	1.30	47·5	20·692	+·656	45·3	43·5	1·8	87·8	S. E. 1	10	" "	"
	1.45	47·5	20·692	+·656	46·5	43·8	2·7	80·3	S. E. 2	10	" "	Sprinkling.
	2.	47·5	20·692	+·656	47·0	42·4	4·6	65·7	S. E. 3	10	" "	"
	2.15	48·0	20·692	+·656	44·5	44·5	0·0	100·0	S. E. 3	10	" "	Very cloudy.
	2.30	49·8	20·692	+·653	50·5	45·5	5·0	64·6	S. E. 4	10	" "	Sprinkling.
	2.45	50·2	20·692	+·651	50·0	47·0	3·0	78·6	S. E. 3	10	" "	Very cloudy.
	3.	50·5	20·694	+·653	48·5	45·2	3·3	77·7	S. E. 3	8	" "	" "
	3.15	53·5	20·690	+·645	52·0	47·2	4·8	68·9	S. E. 2	10	" "	Rain.
	3·30	53·2	20·688	+·643	52·0	47·2	4·8	68·9	S. E. 3	8	" "	Cloudy.
	3·45	53·5	20·680	+·635	52·2	47·0	5·2	66·0	S. E. 2	7	" "	Cool.
	4.	53·4	20·666	+·621	52·3	47·2	5·1	66·0	E. 2	7	" "	"
	4.15	53·5	20·664	+·619	52·4	47·8	4·6	68·9	E. 1	7	" "	"
	4.30	53·6	20·662	+·617	52·6	48·3	4·3	72·7	E. 1	6	" "	"
	4.45	54·3	20·660	+·613	54·0	47·3	6·7	57·9	E. 1	6	Nimbus stratus.	Cool.†
	5.	54·2	20·658	+·611	52·4	47·7	4·7	68·0	E. 1	5	" "	"
	5.30	53·4	20·656	+·611	52·3	47·2	5·1	66·0	E. 1	5	" "	"
	6.	51·0	20·651	+·610	50·6	46·2	4·4	71·6	E. 1	4	" "	"
	6.30	48·5	20·644	+·608	47·8	44·7	3·1	77·2	E. 1	3	" cirrus.	"
	7.	47·3	20·644	+·610	47·7	42·6	5·1	62·4	S. E. 1	2	Cirro stratus.	"

* Took barometer in.

† Put barometer on tree again.

Barometer 2219, *at Station in Camp Nassau.* (4.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D –	R. H.	Wind, direction and force (1 – 10).	Clouds (1 – 10).	Nature of clouds.	REMARKS.
Saturday, August 18th, 1877.	7.	46·4	20·633	+·601	46·0	43·2	2·8	80·3	....	9	Cumulus nimbus.	Cool and cloudy.
	7.30	49·6	20·639	+·601	48·5	45·0	3·5	74·3	....	9	“ “	“ “
	8.	51·3	20·646	+·605	49·7	45·2	4·5	67·6	E. 1	9	“ “	“ “
	8.30	53·4	20·650	+·605	51·6	46·5	5·1	65·3	S. E. 1	8	“ “	“ “
	9.	53·6	20·654	+·609	51·6	46·5	5·1	65·3	S. 2	9	“ “	“ “
	9.15	53·4	20·655	+·610	51·4	45·6	5·8	61·8	S. 2	9	“ “	“ “
	9 30	53·9	20·656	+·611	52·1	46·7	5·4	65·3	S. 1	9	“ “	“ “
	9.45	53·4	20·659	+·614	50·6	45·1	5·5	61·8	S. 1	9	“ “	“ “
	10.	53·6	20·661	+·616	51·4	45·9	5·5	61·8	S. 1	9	“ “	“ “
	10.15	53·8	20·662	+·617	52·3	46·8	5·5	62·6	S. 1	9	“ “	“ “
	10.30	54·4	20·662	+·615	52·5	46·8	5·7	62·6	S. 1	8	“ “	“ “
	10 45	55·3	20·660	+·611	57·7	46·8	10·9	37·9	S. 1	6	“ “	“ “
	11.	58·8	20·660	+·606	56·7	49·3	7·4	56·9	S. E. 2	4	Cumulus.	Sun out.
	11.15	59·2	20·658	+·602	57·6	49·7	7·9	54·5	S. E. 2	5	“	“ “
	11.30	60·7	20·658	+·600	58·3	51·1	7·2	58·4	S. E. 2	6	“	Pleasant.
	11.45	59·0	20·658	+·602	56·5	49·2	7·3	56·9	S. 2	8	“	“
	12.	57·8	20·660	+·608	55·0	48·8	6·2	61·3	S. W. 3	10	Nimbus.	Rain.
	P.M.											
	12.15	56·4	20·656	+·606	53·5	50·1	3·4	79·8	S. 1	10	“	Stopped a little.
	12.30	57·3	20·658	+·606	54·1	49·2	4·9	70·2	S. 1	9	Cumulus nimbus.	Cloudy ; rain.
	12.45	56·2	20·659	+·609	53·4	49·8	3·6	76·3	S. 1	9	“ “	Raining still.
	1.	53·6	20·658	+·613	51·2	48·4	2·8	82·2	S. 1	10	“ “	“ “
	1.15	54·7	20·653	+·610	51·0	47·6	3·4	78·6	W. 1	10	Nimbus.	Rain stopped.
	1.30	52·4	20·650	+·607	51·1	47·5	3·6	75·3	....	10	“	Calm.
	1.45	51·8	20·648	+·607	51·4	46·8	4·6	68·3	....	10	“	“
	2.	52·5	20·646	+·603	51·9	47·0	4·9	68·9	....	10	“	“
	2.15	54·7	20·644	+·597	52·4	47·2	5·2	76·0	....	10	“	“
	2.30	53·4	20·630	+·591	53·2	48·7	4·5	69·6	....	9	“	“
	2.45	53·4	20·628	+·583	52·1	47·3	4·8	68·9	....	9	“	“
	3.	53·7	20·625	+·580	52·3	47·8	4·5	68·9	....	9	“	“
	3.15	53·8	20·625	+·580	52·3	47·7	4·6	68·9	E. 1	9	“	“
	3.30	52·7	20·629	+·586	51·0	47·4	3·6	75·3	S. 1	9	“	“
	3.45	51·8	20·631	+·591	50·8	47·2	3·6	75·3	W. 1	9	“	Cool.
	4.	50·1	20·630	+·591	49·1	45·4	3·7	74·3	W. 1	10	“	“
	4.15	50·6	20·630	+·591	49·4	45·3	4·1	71·0	W. 1	10	Cumulus	“
	4.30	51·5	20·632	+·591	49·6	45·1	4·5	67·6	W. 2	9	“	“
	4.45	51·8	20·633	+·592	49·2	45·0	4·2	71·0	W. 2	9	“	“
	5.	50·4	20·630	+·591	48·7	45·0	3·7	74·3	W. 1	9	“	“
	5.30	51·2	20·628	+·587	49·8	46·2	3·6	74·8	S. 1	7	Cumulus stratus.	“
	6.	50·4	20·628	+·589	48·7	46·0	2·7	81·5	....	7	“ “	Rain.
	6.30	50·0	20·628	+·589	46·9	45·9	1·0	92·1	...	8	“ “	“
	7.	49·8	20·628	+·590	46·8	45·6	1·2	92·1	....	9	“ “	“

Barometer 2219, *at Station in Camp Nassau.* (4.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D –	R. H.	Wind, direction and force (1 – 10).	Clouds (1 – 10).	Nature of clouds.	REMARKS.
Monday, August 20th, 1877.	9.30	54·2	20·662	+·615	50·5	43·4	7·1	51·5	N. W. 3	4	Cumulus.	Cool and pleasant.
	9.45	54·5	20·662	+·615	52·0	44·0	8·0	47·2	N. W. 4	5	" and stratus.	" " "
	10.	56·2	20·662	+·612	55·5	44·3	11·2	33·3	N. W. 5	6	" "	" " cloudy.
	10.15	55·0	20·660	+·611	54·8	43·5	11·3	32·0	N. W. 6	7	" "	" " "
	10·30	57·5	20·660	+·608	56·2	44·8	11·4	33·3	N. W. 6	8	" "	" " "
	10.45	59·0	20·660	+·604	57·5	45·0	12·5	28·6	N. W. 5	8	" "	" " "
	11.	57·5	20·658	+·606	55·0	43·5	11·5	29·8	N. 4	9	" "	Sprinkling.
	11.15	55·0	20·656	+·605	53·5	43·0	10·5	34·1	N. 5	8	" "	Little rain and hail.
	11.30	56·5	20·658	+·608	54·0	44·5	9·5	39·9	N. 6	7	" "	Clearing.
	11.45	58·0	20·658	+·604	56·5	44·0	12·5	27·2	N. W. 3	6	" "	"
	12.	59·5	20·656	+·600	58·0	44·2	13·8	23·5	N. W. 4	7	" "	Cool and cloudy.
	P.M.											
	12.15	57·0	20·656	+·604	55·5	43·0	12·5	25·8	N. W. 3	7	" "	" " "
	12.30	56·0	20·656	+·606	54·0	41·5	12·5	22·8	N. 5	8	" "	Rain.
	12.45	57·5	20·654	+·602	54·2	42·0	12·2	26·4	N. 6	7	" "	"
	1.	57·8	29·654	+·604	54·5	42·5	12·0	26·4	N. 5	9	" "	Cool and clearing.
	1.15	59·5	20·654	+·598	55·5	43·0	12·5	25·8	N. 4	8	" "	" " "
	1.30	55·5	20·654	+·605	57·0	44·5	12·5	27·2	N. W. 6	9	" "	"
	1.45	53·5	20·654	+·599	52·5	41·2	11·3	29·2	N. W. 7	9	" "	Hail.
	2.	55·8	20·650	+·601	54·5	42·8	11·7	28·4	N. 6	8	" "	Clearing.
	2·15	52·2	20·650	+·607	49·5	40·4	9·1	37·3	N. 7	9	" "	Cool.
	2.30	52·5	20·648	+·605	49·2	41·4	7·8	46·6	N. 6	8	" "	Clearing.
	2.45	51·5	20·648	+·607	49·5	40·4	9·1	37·3	N. 5	8	" "	Cloudy and cool.
	3.	54·5	20·648	+·601	53·8	43·8	10·0	36·3	N. 5	7	" "	Sprinkling.
	3·15	53·8	20·648	+·603	52·2	40·5	11·7	25·4	N. 6	8	" "	Cloudy.
	3·30	54·5	20·648	+·601	53·4	41·0	12·4	24·9	N. W. 6	8	" "	Cool and cloudy.
	3 45	56·5	20·648	+·598	53·8	41·4	12·4	24·9	N. W. 5	7	" "	Clear.
	4.	43·5	20·648	+·603	51·0	40·0	11·0	27·6	W. 4	6	" "	" and cool.
	4·15	52·8	20·646	+·603	50·5	40·1	10·4	32·2	W. 5	6	" "	" " "
	4·30	52·0	20·646	+·603	49·5	41·0	8·5	41·2	W. 3	5	Cumulus.	" " "
	4.45	50·5	20·644	+·605	47·2	40·0	7·2	48·3	W. 2	4	"	" " "
	5.	51·0	20·644	+·603	48·0	41·2	6·8	52·3	W. 4	4	"	" " "
	5.30	49·5	20·644	+·606	47·0	40·4	6·6	51·3	W. 3	3	"	" " "
	6.	48·4	20·644	+·608	46·2	40·2	6·0	54·3	W. 4	5	"	" " "
	6·30	47·0	20·644	+·610	45·0	40·4	4·6	64·1	W. 3	3	"	" " "
	7·	44·0	20·642	+·613	42·0	40·2	1·8	86·9	W. 1	2	"	" and cold.

Barometer 2219, *at Station in Camp Nassau.* (4.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D –	R. H.	Wind, direction and force (1 – 10).	Clouds (1 – 10).	Nature of clouds.	REMARKS.
Tuesday, August 21st, 1877.	9.	53·8	20·642	+·597	52·2	39·8	12·4	21·6	N. W. 5	4	Cumulus.	Cool and cloudy.
	9.15	53·5	20·642	+·597	52·0	40·0	12·0	23·3	N. W. 4	5	“	“ “ “
	9.30	55·2	20·642	+·593	54·5	42·0	12·5	24·3	W. 4	6	“	“ “ “
	9.45	54·5	20·642	+·595	52·2	40·0	12·2	23·3	W. 5	6	“	“ “ “
	10.	55·0	20·642	+·593	53·0	40·5	12·5	21.2	W. 4	6	“	“ “ “
	10.15	....	....	....	....	....	....	....	....	..	......	....
	10.30	....	....	....	....	....	....	....	....	..	......	....
	10.45	57·5	20·642	+·590	56·8	41·2	15·6	11·8	W. 5	7	Cumulus and str.	....
	11.	56·2	20·642	+·592	52·5	40·8	11·7	25·4	W. 6	9	“ “	Hail.
	11.15	55·0	20·640	+·591	52·0	41·0	11·0	29·2	W. 6	9	“ “	“
	11.30	....	....	....	....	....	....	....	....	..	.....	....
	11.45	....	....	....	....	....	....	....	....	..	... ..	....
	12.	57·4	20·642	+·590	54·5	41·4	13·1	20·8	N. W. 6	8	Cumulus and str.	Clear.
	P.M.											
	12.15	58·0	20·642	+·588	56·2	42·0	14·2	18·6	N. W. 5	7	“ “	Cloudy.
	12.30	58·5	20·642	+·588	56·0	42·5	13·5	20·5	N. W. 4	7	“ “	Clear.
	12.45	59·2	20·644	+·588	55·5	42·0	13·5	20·5	N. W. 5	6	“ “	“
	1.	60·0	20·644	+·586	56·0	42·0	14·0	18·6	N. W. 5	7	“ “	“
	1.15	61·5	20·644	+·584	57·0	42·2	14·8	16·8	W. 6	8	“ “	“
	1.30	61·5	20·644	+·584	58·0	42·8	16·2	11·9	W. 6	8	“ “	“
	1.45	61·6	20·644	+·584	57·5	43·0	14·5	18·3	W. 5	9	“ “	Cloudy.
	2.	62·0	20·640	+·579	56·8	42·8	14·0	18·6	W. 4	7	“ “	“
	2.15	62·5	20·636	+·577	55·0	42·5	12·5	24·3	W. 7	8	“ “	“
	2.30	56·0	20·632	+·582	54·5	40·2	14·2	15·4	W. 7	8	“ “	“
	2.45	60·0	20·630	+·572	57·5	42·4	15·1	15·1	W. 5	7	Cumulus.	Clear.
	3.	55·8	20·630	+·581	54·0	40·5	13·5	17·2	W. 5	8	“	Cloudy.
	3.15	58·0	20·630	+·576	56·5	42·8	13·7	20·5	W. 6	7	“	“
	3.30	58·6	20·630	+·576	57·0	42·2	14·8	16·8	W. 5	6	“	“
	3.45	58·2	20·630	+·576	56·0	42·2	13·8	20·5	W. 4	5	“	Clear.
	4.	56·8	20·626	+·576	55·0	40·8	14·2	15·4	W. 3	4	“	“
	4.15	54·5	20·624	+·577	53·5	40·0	13·5	17·2	W. 5	4	“	“ and cool.
	4.30	56·2	20·622	+·572	54·8	42·0	12·8	24·3	W. 5	4	“	“ “ “
	4.45	55·5	20·622	+·573	53·8	39·5	14·3	13·7	W. 5	3	“	“ “ “
	5.	54·5	20·622	+·575	53·2	39·0	14·2	13·7	W. 5	2	“	“ “ “
	5.30	52·5	20·620	+·577	50·5	38·0	13·5	13·7	W. 6	2	“	“ “ cold.
	6.	51·5	20·620	+·579	50·0	37·5	12·5	16·0	W. 6	1	“	“ “ “
	6.30	48·2	20·618	+·582	47·0	36·8	10·2	26·0	W. 2	0	......	“ “ “
	7.	45·4	20·614	+·584	45·0	35·4	9·6	27·1	W. 4	0	......	“ “ “

Barometer 2219, *at Station in Camp Nassau.* (4.)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D –	R. H.	Wind, direction and force (1 – 10).	Clouds (1 – 10).	Nature of clouds.	REMARKS.
Wednesday, August 22d, 1877.	9.	54·5	20·618	+·571	51·5	38·0	13·5	13·7	S. W. 4	1	Stratus.	Clear and cool.
	9.15	53·8	20·618	+·573	51·8	38·0	13·8	13·7	S. W. 4	1	“	“ “ “
	9.30	54·2	20·618	+·571	52·8	38·6	14·2	11·9	W. 5	0	......	“ “ “
	9.45	55·5	20·620	+·571	53·0	39·2	13·8	15·5	S. W. 5	0	......	“ “ “
	10.	55·8	20·618	+·569	54·5	40·2	14·3	15·4	W. 3	0	......	“ and pleasant.
	10.15	56·6	20·618	+·568	54·2	40·0	14·2	15·4	W. 4	0	......	“ “ “
	10.30	57·2	20·618	+·566	55·0	40·2	14·8	13·6	W. 5	0	......	“ “ “
	10.45	57·8	20·618	+·566	55·5	41·0	14·5	15·3	W. 5	0	......	“ “ “
	11.	58·0	20·620	+·566	55·0	40·6	14·4	15·4	S. W. 4	0	......	“ “ “
	11.15	58·0	20·620	+·566	55·5	40·8	14·7	13·6	S. W. 5	0	......	“ “ “
	11.30	59·0	20·620	+·564	56·2	41·0	15·2	13·6	W. 4	0	......	“ “ “
	11.45	60·6	20·620	+·562	57·4	41·5	15·9	11·8	S. W. 4	0	......	“ “ “
	12.	60·0	20·620	+·562	56·6	43·4	13·2	23·9	S. W. 5	0	......	“ “ “
	P.M.											
	12.15	60·8	20·620	+·562	56·0	42·2	13·8	20·5	W. 3	0	......	“ “ “
	12.30	61·4	20·620	+·560	59·0	41·4	17·6	5·7	W. 4	0	......	“ “ “
	12.45	60·5	20·616	+·558	58·2	40·0	18·2	2·5	W. 3	0	......	“ “ “
	1.	61·5	20·616	+·556	54·6	41·0	13·6	18·9	W. 4	0	......	“ “ “
	1.15	62·2	20·616	+·555	58·2	40·0	18·2	2·5	W. 5	0	......	“ “ “
	1.30	62·4	20·616	+·555	59·0	41·2	17·8	5·7	W. 4	0	......	“ “ “
	1.45	62·5	20·616	+·555	60·0	42·2	17·8	7·4	N. W. 3	0	......	“ “ “
	2.	63·0	20·616	+·553	60·2	42·0	18·2	6·0	W. 3	0	......	“ “ “
	2.15	64·2	20·616	+·551	60·5	42·2	18·3	6·0	W. 4	0	......	“ “ “.
	2.30	64·5	20·612	+·557	62·5	42·0	20·5	....	W. 5	0	......	“
	2.45	64·0	20·612	+·557	62·0	41·8	20·2	....	W. 3	0	......	“
	3.	63·8	20·610	+·557	61·0	42·2	18·8	4·6	W. 4	0	......	“
	3.15	61·8	20·606	+·546	60·0	42·0	18·0	6·0	W. 6	0	......	“
	3.30	61·5	20·604	+·544	59·5	42·2	17·3	8·8	W. 4	0	......	“
	3.45	62·0	20·602	+·541	60·0	42·5	17·5	7·4	W. 5	0	......	“
	4.	61·8	20·602	+·542	60·0	42·4	17·6	7·4	W. 4	0	......	“
	4.15	61·5	20·600	+·540	59·8	42·2	17·6	7·4	W. 3	0	......	“
	4.30	60·0	20·600	+·542	59·5	42·0	17·5	7·4	W. 4	0	......	“
	4.45	59·8	20·600	+·544	59·0	41·8	17·2	7·2	W. 5	0	......	“
	5.	58·5	20·596	+·542	57·0	40·2	16·8	6·9	W. 6	0	......	Cool.
	5.30	57·0	20·588	+·536	56·0	39·8	16·2	6·7	W. 4	0	......	“
	6.	54·0	20·584	+·537	53·2	38·5	14·7	10·1	W. 3	0	......	Clear.
	7.	46·0	20·576	+·544	42·5	37·0	15·5	4·6	W. 4	0	......	“

Barometer 2219, *at Station in Camp Nassau.* (4)

DATE.	A.M.	T.	B.	32° B.	D. B.	W. B.	D —	R. H.	Wind, direction and force (1 — 10).	Clouds (1 — 10).	Nature of clouds.	REMARKS.
Thursday, August 23d, 1877.	9.	60·8	20·616	+·558	59·0	41·5	17·5	5·7	W. 3	2	Stratus.	Clear.
	9.15	60·5	20·618	+·560	58·5	41·2	17·3	7·2	W. 4	2	“	“
	9.30	61·8	20·622	+·562	60·5	42·8	17·7	7·4	S. W. 3	2	“	“
	9.45	61·2	20·624	+·564	60.5	42·2	18·3	6·0	S. W. 3	2	“	“
	10.	62·0	20·624	+·563	60·2	42·4	17·8	7·4	S. W. 2	1	“	“
	10.15	62·5	20·624	+·563	61·0	42·8	18·2	6·0	S. W. 3	1	......	“
	10.30	63·0	20·624	+·561	62·4	43·0	19·4	5·0	S. W. 4	0	......	“
	10.45	64·2	20·624	+·559	63·2	43·8	19·4	5·0	S. W. 3	0	... ..	“
	11.	64·0	20·626	+·561	63·0	43·2	19·8	3·7	S. W. 3	0	......	“
	11.15	64·5	20·626	+·561	62·4	44·0	18·4	9·2	S. W. 4	2	Cumulus.	“
	11.30	64·2	20·626	+·561	62·4	44·5	17·9	10·6	W. 3	2	“	“
	11.45	65·5	20·626	+·559	64·0	44·0	20·0	4·3	W. 4	3	“	“
	12.	67·0	20·626	+·555	65·8	41·0	24·8	....	W. 4	5	“	“
	P.M.											
	12.15	67·5	20·626	+·555	66·0	43·8	22·2	....	W. 3	6	“	Cloudy.
	12.30	66·0	20·626	+·555	62·2	43·8	18·4	7·6	W. 4	7	“	“
	12.45	65·2	20·626	+·559	61·5	42·6	18·9	4·6	S. W. 5	8	“	“
	1.	65·5	20·628	+·561	61·8	42·4	19·4	3·3	S. W. 4	8	“	“
	1.15	64·8	20·628	+·563	61·5	42·0	19·5	2·1	S. W. 3	8	“	“
	1.30	65·0	20·624	+·557	61·5	43·0	18·5	6·3	S. W. 4	8	“	“
	1.45	65·2	20·624	+·557	62·5	43·2	19·3	5·0	S. W. 3	8	“	“
	2.	64·5	20·624	+·559	60·8	42·6	18·2	6·0	S. W. 5	8	“	“
	2.15	63·0	20·624	+·561	60·2	42·5	17·7	7·4	S. W. 4	8	“ and nimbus.	“
	2.30	64·6	20·624	+·559	61·5	43·0	18·5	6·3	S. W. 3	7	“ “	Clear,
	2 45	67·2	20·620	+·559	65·5	44·0	21·5	....	S. W. 4	6	“ “	“
	3.	64·0	20·620	+·555	62·0	42·8	19·2	3·3	S. W. 5	5	“ “	Cloudy.
	3.15	65·5	20·618	+·551	63·5	44·0	19·5	3·7	S. W. 4	4	“ “	Clear.
	3.30	62·3	20·608	+·547	60·0	41·5	18·5	3·0	W. 2	7	“ “	Cool.
	3.45	62·5	20·608	+·547	59·6	41·5	18·1	4·3	W. 2	6	“ “	“
	4.	60·3	20·600	+·542	59·1	40·5	18·6	....	S. W. 1	9	“ “	“
	4.15	60·3	20·599	+·541	58·8	41·7	17·1	7·2	S. 2	10	“ “	“
	4.30	60·1	20·600	+·542	58·8	40·8	18·0	2·5	S. 1	10	“ “	“
	4.45	59·5	20·602	+·546	58·4	41·1	17·3	7·2	W. 2	10	“ “	“
	5.	59·3	20·600	+·544	57·6	39·8	17·8	2·1	W. 3	10	“ “	“
	5.30	59·6	20·598	+·542	58·1	40·5	17·6	3·9	W. 1	9	“ “	“
	6.	59·2	20·595	+·539	58·4	39·8	18·6	....	S. 3	7	“ “	“
	6.30	56·8	20·589	+·539	55·5	39·6	15·9	8·4	S. E. 2	4	“ stratus.	“
	7.	55·8	20·584	+·535	56·3	38·6	15·7	6·5	S. 2	3	“ “	“

APPENDIX.

DIARY OF THE TRIP.

DIARY OF THE TRIP.

JUNE 21, THURSDAY.

AT 7 P.M. the members of the expedition assembled in the study of Prof. Kargé, and thence proceeded to Dr. McCosh's house, to bid him good-by. He called us into his study and prayed for our safety and success, and bid us all an affectionate good-by. We then went on the same errand to Dr. Guyot's, where he and his good wife wished us all possible success, and hoped we should bring back our own bones in safety, as well as many fossils. When we reached the depot we found a large number of the students had gathered, and they sent us off with the old-time cheer and rocket. Leaving there at 8.10 we arrived at the Junction, where we said good-by to many of our friends and waited for the 10.20 train which was to stop and attach our baggage-car and Pullman, which were waiting there for us. Our Pullman car was the best on the road; it was the President's, and was kindly placed at our disposal by Mr. Pullman. Its name was the Rhode Island. Our berths were portioned out by lot, and we had No. 11, which we soon turned into, and with the exception of being waked up at Philadelphia by some fellows who boarded the train there, passed a quiet night.

JUNE 22, FRIDAY.

We all awoke early, as many of us had not seen the Horse Shoe curve, and those who had were almost as anxious to see it again. Reached Pittsburg at two o'clock and took dinner. Then going over the Pittsburg, Fort Wayne and Chicago Railroad through Ohio, nothing of interest occurred till we reached Alliance. We had now for the most part assumed our blue shirts and uniform costumes, which attracted the attention of the natives of that rustic town. One of their number, with more valor than discretion, singling out General

Kargé as the leader of the party, approached him, and in the mildest tones asked, "Is this a travelling base-ball club, sir?" He was immediately squelched by the stentorian tones of the General, as he replied, "No, sir; this is a circus!" and the General was not far from right, for the whole company afterward proved a source of entertainment to many a native of the far West.

JUNE 23, SATURDAY.

We arrived early this morning in Chicago, where we were met at the depot by Mr. Hathaway, of the Grand Pacific Hotel, who kindly invited us to partake of a very elegant breakfast given as a compliment to our party. We took our chronometer to the Douglass Observatory and compared it with the standard there, and at 12.30 met the rest of the party (who had separated to visit various points of interest in the city) at the Chicago and Alton depot. We took possession of the palace-car "Baltic," and giving three cheers and a rocket for our friends in Chicago, who had gathered at the depot to see us off, we started on our long prairie ride. At twelve o'clock in the evening, as we were approaching the bridge at Louisiana, across the Mississippi, a number of us were enjoying the moonlight in the engine-cab, when we saw a sight which curdled our blood. A trackman who had just been paid off was going home intoxicated, and had lain down on the track to sleep. Before we could say a word we were on and over him. We stopped, went back, and found his body, and did what we could for him, but to no avail; so we left him at a section-house to die.

JUNE 24, SUNDAY.

The first rays of light found us rolling along the muddy bottom of the Missouri. The unanimous verdict concerning our breakfast at Lexington Junction was that it was "very poor." Soon after leaving this place we encountered a novel experience in railroading. We plunged in water up to the top of the wheels, and moved along at a snail's pace for about a mile and a half, constantly expecting to be stopped by the fires being put out in the engine. We came into Kansas City two hours late. Here we found, to our astonishment, that our baggage-car would not fit the rails of the Kansas Pacific Road, and our whole party had to turn in and transfer our baggage from one car to another. We did this in the short space of twenty minutes, though we had upwards of five thousand pounds to move. This gave quite a reputation to our "tender-foot" party for muscle and energy. The most of the afternoon we spent in singing Moody and Sankey's hymns, with Dunning as leader of the choir.

JUNE 25, MONDAY.

We awoke to find ourselves rolling out toward the plains. We spent the morning in the baggage-car, where some of us tried our marksmanship on the antelope we passed; none of them, however, suffered. About noon we passed a small station called First View, one hundred and sixty miles from Pike's Peak, and as an illustration of the clearness of the atmosphere, we would mention the fact that the tip of the snow-capped mountain was just in sight over the rolling prairies. We reached Denver at six in the evening, and after investigating the town, took supper at Charpiot's Restaurant, "the Delmonico (?) of the West."

JUNE 26, TUESDAY.

We pitched our camp a half mile west of Denver, and commenced assorting our baggage for our proposed trip in Colorado. This was our first regular camp and our first experience under military discipline. The camp was called "Camp Lynch," because we discovered that three horse-thieves had been lynched there some years before.

JUNE 27, WEDNESDAY.

We spent all day in camp selecting horses. As the animals from which the party were to make a selection were Indian ponies, lately captured from the Sioux tribe, the efforts on the part of some of the members of the party to ride them caused considerable amusement, and their motions were more grotesque than graceful.

JUNE 28, THURSDAY.

At four in the afternoon, everything being in readiness, we broke camp; and falling into proper marching order, we passed through the city to the astonishment of its peaceful inhabitants, who flocked out to see the warlike display. We took up our line of march along the South Fork of the Platte River, and camped four miles out of the city on its banks. Dulles and Dunning mounted guard for the night.

JUNE 29, FRIDAY.

Continuing on in the same line southward, after passing Littleton, we turned to the left along Plum Creek for thirteen miles, and then camped at Van Wormer's ranche. Here the party indulged in the home luxuries of milk and eggs to an enormous extent.

JUNE 30, SATURDAY.

When we left the camp this morning we received the cheering news that military discipline was at an end, and that each one might direct his horse where his inclination led him, provided he came to the appointed rendezvous at night. Leaving the main party, we struck out straight across the foot-hills for Castle Rock, so named from a square rock, about 90 feet high, on the top of a mountain overlooking the railroad station. As we rode into the village we saw a sign with the enticing words, "Strawberries and ice-cream," on it, and forthwith prepared ourselves to enjoy them. But on a closer inspection of the aforesaid sign, we found printed below, in microscopic characters, "On the 4th"; so we had to be satisfied with some sour strawberries and some very dry ginger-snaps. We went on about eight miles further to Leverson's ranche, the appointed meeting-place for the night.

Here we waited for the rest of the party, who came straggling in one by one, and finally Lynde brought the startling information that the "commissary department" had broken down six miles back; and as the housekeeper was not prepared for the reception of sixteen hungry troopers, the chance of our getting a supper seemed to be rather slight. Finally, not caring to have us starve, she gave us freely of what she had in large store, viz., milk and biscuits. She also very kindly offered us for sleeping purposes the only empty room she had in the small log cabin. Taking our saddles for pillows, and fully booted and spurred, we laid down; but not to peaceful slumbers.

JULY 1, SUNDAY.

Sabbath morning was spent in anxiously awaiting the arrival of the wagons. They finally reached us at 12 M. All hands then set to work to prepare dinner, which was to answer for two meals. We enjoyed this meal more than any that we had since starting out. The afternoon was spent quietly in camp; the duties of correspondence were faithfully attended to; and the kind hospitality of Dr. Leverson was very refreshing and fully appreciated.

July 2, Monday.

After leaving Leverson's ranche we soon reached Larkspur, and, turning to the right, passed across the plains and came to Lake Divide, which is on the summit of the transverse range of hills separating the Platte River from the Arkansas River. The elevation is 7,554 feet. Five miles from the lake we came to Monument, and encamped about a mile further on, near the road. We took a tramp up the Little Giant mountain, from which we had a beautiful view of Pike's Peak and the Front Range. These sights were new and strange, and they filled us with admiration for the sublime nature we were brought in such close contact with. On our road up and on the return we passed through long, beautiful meadows with high eroded columns of sandstone, which seemed very grand. The whole seemed to us rather more like an enchanted land than a reality.

July 3, Tuesday.

Starting early in the morning, and passing through Edgerton, we skirted along the eastern edge of Monument Park. We reached Colorado Springs at twelve o'clock, having been on the road four days and a half, and having ridden seventy-five miles. After a good dinner we set out again to find our party, and rode over to Glen Eyre, which was full of natural wonders new to us, in its curiously upturned strata. Not finding them there, we went to the Garden of the gods, where the wagons were already drawn up, and a permanent camp formed near the Gateway.

July 4, Wednesday.

The members of the various departments represented in the expedition now set to work in real earnest; and we commenced our part by establishing the height of a base at the Beebee House in Manitou Springs for the purpose of measuring Pike's Peak. This was finished by noon; and M. choosing the lower station, L. started, after dinner, to climb the mountain, and reached the Lake House in the evening after some adventures not worth noting.

JULY 5, THURSDAY.

L. started early for the summit, having agreed with M. to carry on simultaneous observations from 9.30 to 10.30 A.M. This was accomplished, and our first attempt at measuring these mountains will be seen to have been successful and very encouraging. The mountain was descended with ease, and the camp reached by evening. The incidents of the climb were so like those of other parties performing the same feat, that they are hardly worth repetition.

JULY 6, FRIDAY.

In order that we might ascertain the elevation of our base at the Beebee House, a series of observations was conducted in the morning between L. at that place and M. at the Colorado Springs Railroad depot. The afternoon was spent arranging our instruments in the camp.

JULY 7, SATURDAY.

We spent the day visiting the Springs and sampling them all. They were chiefly soda, iron, and magnesia. We took the temperature of the various springs, and found it to vary from 58° to 68° F.

JULY 8, SUNDAY.

We spent most of the day dodging the rain, as it poured hard all the time. Attended the only Episcopal service which was held in the morning.

JULY 9, MONDAY.

This morning we left the main party in their camp and went on ahead in order to be able to prosecute our work. Leaving Manitou at 9.30 we commenced our climb over the Front Range by the way of the Ute Pass. The scenery was very beautiful, and was enjoyed as much as possible as we hurried along on our ponies in light travelling order. At two o'clock we reached "Silver Spring Ranche," having passed a very pretentious hotel called the "Green Mountain House," where we were informed by the landlady that she "had quit keeping stoppers." The proprietor of the Silver Spring Ranche was the far-famed Dr. Johnson, and he treated us very nicely. After dinner we rode fifteen miles farther on to Florissant, where we were entertained in royal style by the stately host of the place, Judge Castello. This old place was crowded with relics of the chase and curiosities of all sorts. There was an old Indian fort directly back of the house; it had a circular wall and several outworks. We examined them all carefully, and in the evening the Judge regaled us with stories about old times, and his encounter with the Indians. (We have since learned of the death of our good old friend, with regret.)

JULY 10, TUESDAY.

Four miles from Florissant we crossed the north branch of the South Fork of the Platte River. From here for seven miles our road lay through a beautiful district leading to South Park—high granite walls and immense boulders lying on either side of the way. Coming to Wilkinson's ranche we were refused water for our horses and had to ride on. After passing over a small divide we saw the broad expanse of South Park some hundreds of feet below, stretched out like a large map, dotted here and there with a ranche, and the long Platte River shining like a silver line throughout its entire length. While crossing this open piece of prairie to what appeared to be the nearest ranche, we saw a most wonderful display of clouds. The heavy cumulus masses rose up higher and higher till they rolled over one bank after another in great confusion and presented a most imposing sight. Reaching the ranche, we approached the house, hoping to get some water, but the door was slammed in our faces by a wrathful female, who screamed out that she "didn't have no water for stoppers." Our feelings at such a reception can be imagined better than expressed. We next went over to Hartsell's, where we at last found what we wanted, after having come for it nineteen miles over a very hot road. But here was another difficulty; a "round-up" was in progress, and all available quarters were occupied, so we had to urge our way on again. A round-up is the technical term out here for a gathering of all the cattle on the park, for the purpose of branding the calves and counting the herds. This is held every year. Large numbers of cattle were already there, and many more were to come. This was the favorite spot for this purpose, as water and grass are very plenty. Finally we reached Clark's, well tired out and rejoiced at the prospect of a rest. We put our horses up, and went off to take a look at the neighborhood, which we found very pleasant.

In the evening we experimented practically on the benefits and efficacy of the hot sulphur spring near the house, and were delighted. Its temperature was 150° F.

JULY 11, WEDNESDAY.

Leaving Clark's, we soon came to a division in the road, which, a sign told us, was the way to the much-sought-for San Juan country. The road looked well worn. We had frequently passed, since leaving Colorado Springs, the teams of travellers who were slowly going to and from that Mecca of the gold-hunter. We reached Fairplay at eleven; and M. staying on the site of an old building whose elevation was known, L. went on to Alma in order to make a station at that place, preparatory to measuring several mountains in that region. This work occupied the rest of the day. The town of Alma is considered the highest mountain town in the State, being, according to our measurement, 10,381.5 feet at the St. Nicholas Hotel. Our barometer stood at 20.8 inches, with an average temperature of 72° F. Fairplay is noted for its gulch-mining interests, and the hillsides are tunnelled for miles in all directions by the eager miners. We noticed here the cheerful faces of many Chinamen hard at work. The process is to empty the gold-bearing earth into long sluices, through which runs a rapid stream of water strong enough to carry large boulders, but not powerful enough to wash away the gold, which sinks to the bottom, where it is caught by the mercury behind the riffle-bars, which are placed at intervals transversely to the current. This amalgam is taken out and the gold obtained by volatilizing the mercury. The "wash," as it is called, averages here $11 a day per man.

JULY 12, THURSDAY.

We made corresponding observations in the morning until nine o'clock, when L. started for Mount Lincoln, having previously procured a horse and guide. M. removed his instrument to the spot that had been left by L., and, as agreed upon, continued observations there. On the road up Mount Lincoln, on the sides of Mount Bross, L. visited some mines rich in silver ore. He reached the top of Mount Bross at 10.30, made observations for half an hour, and then continued on the road up Mount Lincoln, the summit of which was reached at 12. Here observations were made; and after taking dinner at some miners' quarters near the top, he commenced the descent. Before reaching the bottom, however, he was quite overcome by the "mountain fever," as it is called there. It is a mild form of typhoid fever, and very harmless if taken care of in time.

JULY 13, FRIDAY.

M. started at 7.30 A.M. for Mount Quandary with the horse and guide, L. remaining in Alma to make corresponding observations, as he felt much better to-day. M. rode up to the entrance of the once famous Montgomery Gulch (where so many thousands of dollars were sunk in 1863, when Montgomery was the largest town in the State; now nothing remains but the ruins of the place). Thence going to the summit of the Hoosier Pass, he turned to the left, and after a very hard and rough climb he reached the top at 12.30, where observations were made. An interesting monument was found on the summit, containing a board, on which was carved, "Kelsey and Tom Campbell, July, 1873." Thence he returned to Alma, reaching it at 6 P.M.

JULY 14, SATURDAY.

M. started to measure Mount Silverheels, leaving L. below. This mountain is a prominent point on the Park Range, affording a good view of the Platte River and South Park. This would be a fine place for transit observation if it were not for the iron present in the mountain, which rendered a small compass completely useless. In the evening the town was enlivened by a horse-race in the streets. All the gambling saloons were open (and it seemed as if almost every other house was one), and the drinking and carousing were carried on till late. Alma has one of the largest hydraulic mines and reduction mills in the State. The principle of these mines is the same as the gulch mines, except that the source of the power is a strong head of water delivered from a large nozzle against the bank of earth, which it undermines and makes short work with.

JULY 15, SUNDAY.

The scenes of the night before were continued all day. Everything went on as usual, except where mines had closed for a wash-up. Sunday is a day for general dissipation, and is spent by the miners in the wildest sorts of vice. Churches are unknown, and there is nothing to remind any one that it is not a week-day. M. went to Fairplay, as we had heard that Osborn was there, with a message from the main party. He came back to say that they intended to go to the Arkansas Valley, and wanted us to come with them. In the evening two men were shot in front of the hotel, in a little row that took place.

JULY 16, MONDAY.

We left Alma at 9 A.M., and found McPherson at Fairplay. We proceeded to the salt works, twenty miles south, where we got our dinner. The rides over the prairie land had a general sameness, which became very tiresome. These salt works are now abandoned as unprofitable. Leaving here, we started in full pursuit of the party, who we learned had spent Sunday here, and had just gone on. This part of the day's journey was very pleasant, as the Trout Creek Valley is quite a pretty place. We overtook the party just as they were going into camp in the Arkansas Valley, after a ride of sixty miles, the longest as yet made on the trip.

JULY 17, TUESDAY.

M. rode down the valley of the Arkansas six miles to Helena, the height of which place was known, and prepared to make corresponding observations; while L. set off early for Mount Princeton, a very beautiful and symmetric mountain immediately to the west of our camp. L. found no particular difficulty until within 1,500 feet of the top, when his only way lay over a bed of *débris* such as he had never experienced before; the size of the boulders being such that nothing but the hardest sort of crawling would answer. The summit was, however, reached at 12.30 P.M., and several patriotic demonstrations gone through with. A large monument, six feet high by three in diameter, was built, in the centre of which a stick, on which the circumstances were written, was deposited and left as a memento. The scene from this point of view was simply indescribable; the broad valley of the Arkansas spreading immediately below, and the Sawatch Mountains stretching away on either side. It rivals in beauty the scene from Mount Lincoln. It does not combine such an extent of prairie with great mountain regions as does Pike's Peak, but for pure mountain scenery it is very grand. L. returned to camp in the evening to find all the rest gone out fishing, as the rumors of the excellent trout to be found in the neighboring streams were not to be disregarded until verified by even the most unscientifically inclined; 101 of the speckled beauties were caught. M. caught three that weighed nine pounds, one of them weighing three and a half pounds. The principal trouble seemed to be the scarcity of bait, as there was more trouble catching grasshoppers than fish. Every one had fish for supper, and was happy.

JULY 18, WEDNESDAY.

Leaving camp at 9 A.M., we went on ten miles to Riverside, where we met Scott, Speir, and Osborn, who had left the camp some days before on a fossil hunt. At this part of the ride we entered the narrow part of the valley. The rocky gorge down which the foaming river ran presented many varied and picturesque aspects. We soon reached Granite, another lifeless town. Getting our dinner there, we turned to the left to visit the Twin Lake region. On our way up we forded Lake Creek, where the water reached our horses' flanks. At the Lakes we found a very primitive hotel with cotton cloth partitions between the rooms, and a roof made of the tins of tomato cans; but it covered a very obliging and good-hearted hostess, who did all in her power to make it pleasant for us. These lakes lie at the foot of Mount Elbert, and each of them covers about 200 acres. They are plentifully supplied with an excellent variety of mountain trout, on which we tried our skill with some success.

JULY 19, THURSDAY.

The various members of the party came straggling into this camp during the day, and it was spent in various ways, hunting and fishing. A council was held, at which it was decided that General Kargé, with the Palæontologists, and ourselves, should go to Fort Bridger in Wyoming Territory; the Palæontologists to busy themselves in the neighboring bad lands, and we to go into the Uintah Mountains for the purpose of doing original topographical work.

JULY 20, FRIDAY.

Accompanied by Osborn, we left in the morning, and retraced our way to Granite. Leaving after dinner we followed the Hayden trail straight over the mountains. After a very rough ride, in which we came near losing our way from the scarcity of trail-marks, we finally emerged into the trail leading over the Weston Pass. Following this down the mountain, we soon were out on the level tract of South Park on our way for Fairplay. We reached there at 9 P.M., and, much to our surprise, found that our afternoon ride had been thirty-eight miles instead of eighteen, as we had expected.

JULY 21, SATURDAY.

We travelled over the now familiar road between Fairplay and Alma, and just before we came to Hoosier Pass we were overtaken by a worn-out and dilapidated-looking individual who entertained us by his interesting reminiscences of frontier life. He led us over Fremont's trail of 1853, instead of the regular pass road, and made the trip to Breckenridge very pleasant by his company. Here we discovered that our fellow-traveller was the celebrated "Dick Allen," of the Fairplay *Sentinel.* After leaving the summit of the pass we descended into the valley of the Blue River, which we followed to the little town of Breckenridge, twenty-six miles from Fairplay. The first thing we saw was the grim face of Gen. Logan on the piazza, where he was surrounded by a crowd of admirers. Judge Silverthorn, who was the owner of this hotel, said that the house was full, but if we could sleep in the "corral" we might stay. We examined it and accepted the offer. It was in the upper story of the establishment, under the roof. While we were ridding ourselves of our numerous packages, the Judge disappeared. We found on going down that a drunken fellow had been behaving unseemly in the street, and that our little shrivelled-up judicial authority had made out a warrant, served it himself, and seizing the prisoner by the back of the neck, had kicked him up the side of a hill to the calaboose, although he had complained of being very ill a few minutes before. This little affair gave rise to a trial, which of course we attended. Judge Rieland read from a large and formidable-looking document, "Gibbs, you are charged with disturbing the peace." (*Aside*) "I'm in a hurry, so plead guilty. If you take one of them lawyer fellows, I'll stick you." Gibbs asked how much the fine was, and the Judge announced very formally that he should be fined $1.50 and costs. Whereupon Gibbs asked, in tones that made several "visitors" look around to see where the door was, "Where's my revolver?" He only wanted to pawn it, however. After this the court adjourned for drinks all around.

In the afternoon we went to see a wash-up in one of the neighboring gulch mines. Dick Allen went with us and explained the *modus operandi*. They took out $2800 for 160 days' work. When we returned home we found that there were six of us compelled to sleep in the seven-by-nine corral —the Judge, Dick Allen, we three, and a native hoosier.

JULY 22, SUNDAY.

We were awakened early this morning by Dick Allen saying, "I can't eat my breakfast until I have had six cocktails, and it's about time to commence; so come on, boys." We have spent some very queer days out here, but this beats them all. To get out of the reach of the noise was impossible, and you might think that there was a den of wild animals being fed, or something worse. We heartily recommend Breckenridge as being the most fiendish place we ever wish to see. We were forced to spend the morning and afternoon in the company of men whose language was vile, and whose actions were tinged with a shade of crime that shocked and hurt our senses; never did anything so bestial and so unworthy even a mention by manly lips happen before our eyes. In the morning there was a series of dog-fights. A ring of yelling demoniacs was gathered around the two poor curs. Upon the success or defeat of one or the other large sums of gold-dust were freely wagered. The old Judge innocently remarked that "the men would soon commence," and sure enough they did commence very quick, quarrelling about the slightest thing, and fighting like devils while their breath lasted, which, on account of the rarity of the air at this altitude, was not more than ten minutes. Finally Breckenridge seemed satisfied, and grew quiet outside in the streets, but the men only adjourned to the saloons (almost every other house was one), where their carousing was kept up till late in the night. The evening being very cool, a fire was kindled in the parlor, around which a good many of the "old cases" were gathered, and the amusing stories of frontier and prairie experience served to pass away the hours till bedtime.

JULY 23, MONDAY.

Our friends gathered to see us off. Dick gave us a "send-off" in the way of a cock-tail, as his breakfast-time had not yet come. We were off at seven, and had a delightful ride for ten miles in the cool morning, down the valley of the Blue River. When we came to the Snake Valley, we rode up that stream ten more miles, through a most glorious piece of woodland scenery. We found we were in the neighborhood of Montezuma, and halted at the hotel for our dinner, which turned out to be a regular New York feast—mock-turtle soup, steak with mushrooms, etc. This fact, as well as the presence of New York papers, *Harper's Weekly* and *Monthly*, and the genteel appearance of our host, led us to make inquiries, whereupon he was recognized by two of us as one of those voluntary exiles from society, where he once moved with honor. Leaving at one o'clock, and riding five miles further up, we came to the head-waters of the Snake River at timber line, and saw our trail ahead, stretched along the precipitous side of the mountain which forms the head of the valley. Before and above us, almost 3000 feet, lay the ridge of the Argentine Pass, 13,100 feet in elevation, the highest wagon-road in the United States. After a long, slow ride, we reached the top, going sometimes over snowbanks (for it had not entirely disappeared here yet), sometimes finding barely walking room for our horses. From the summit the scene was perfectly grand. Here we stopped for our lunch, which we had in our saddle-bags, and rested our horses, while we enjoyed the scenery. A further ride of eight miles brought us to the hillside which seems to overhang Georgetown. This is a beautifully situated place, at the head of a valley surrounded by mountains on three sides. We stopped at the Barton House, and received here the news of the great railroad riots in Pittsburg.

JULY 24, TUESDAY.

Before breakfast M. carried a series of levels from the depot of the Clear Creek Railroad up to the hotel, while L. compared the three barometers, as we were to leave an aneroid here with Osborn, and take the two mercurials respectively to Gray and Evans Peaks. M. started for Gray and found a good road to the top. This mountain is visited by many excursionists, being very accessible, and also being one of the highest in the range. L. took the road up Mount Evans, but soon reached a riding limit, and had to climb some 1500 feet before reaching the top. By means of a powerful telescope he found that both observers were at work at the same time, which was very satisfactory. Storms of hail, snow, and rain were experienced by both, and the rain continued the rest of the day. Our canvas coats did good service on this occasion. After our return to Georgetown, and a little supper, we saddled our own horses (which were perfectly fresh, as we had left them here all day to rest) and started down the valley in the rain. We were already wet, and did not care much for a little more, as we wanted to gain on time and space. We raced all the way to Idaho Springs, making the fourteen miles in an hour and a quarter. We went to the Beebee House, which is kept by Mr. Beebee, who is not, however, as good at it as his wife in Manitou Springs. We were treated very nicely though; had a cottage to ourselves, a wood fire, a good supper, and luxuriated in grand style.

JULY 25, WEDNESDAY.

We went to the Springs before breakfast, and enjoyed a warm soda bath very much. Leaving about nine o'clock we rode down part of the cañon, then turning to the right we went over St. George's Hill, and after this one hill was succeeded by another as we descended the foot-slopes of the mountains to the plains. We reached Mount Vernon at 1.30, where we had such an objectionable dinner set before us that its mere appearance disgusted us, and we rode on. It seemed good once more to be on the plains, after our four weeks in the mountains. Osborn left us here to see Prof. Lakes, at

Morrison; while we, seeing Denver sixteen miles off, started for it at headlong speed. We reached the Grand Central Hotel in two hours and a quarter. Then we went to Paul Graham's, where our clean clothes were stored, and when we made our appearance at the hotel, dressed like white men once more, the clerk failed to recognize us—and he was not to blame. After having a good supper we went to the post-office, where we found a bundle of letters and papers which were eagerly investigated, and the evening spent in reading up the news. Osborn came in at eight P.M.

JULY 26, THURSDAY.

We were up early and went to the store to sort out and pack our various boxes. The morning was spent at this work, and everything was done by noon. We shipped the rest of the provisions to Dr. Brackett, at Fairplay, and upon reaching the hotel found General Kargé with the rest of the party. We spent the afternoon resting and talking with the party who had just come in, about their ride across South Park.

JULY 27, FRIDAY.

The day was spent in packing our things up and getting them down to the depot, and in making arrangements for our trip northward on the morrow. We had seen enough of Denver, and wanted to be off.

JULY 28, SATURDAY.

The General had us all up by five o'clock this morning, and after breakfast we started for the depot with our horses. Then from 7 till 12.30 we rode over one of the dryest and warmest stretches of country that can be imagined. Reaching Cheyenne we fed our horses and exercised them, and then shipped them for Fort Bridger. We then took possession of our palace-car "Summit" and boarded for one day at the Interocean Hotel, which treated us very fairly. We had choice bits of game, etc., which were eaten with much relish. The train at three P.M. had three companies of infantry bound eastward to quiet the riots. Cheyenne, it may be noted, is famous for its gambling-saloons and general dissipation.

JULY 29, SUNDAY.

Most of us went to hear the Presbyterian preacher. He was an old Princeton man, and of course was very much interested in us. We strolled around the town and asked some questions. The city is in the open plain, without a shade-tree or irrigating ditch. It is particularly quiet now, we were told, as the Black Hills fever had drawn off the scum of the population. At 1.30 we were off for Fort Bridger, and the ride proved very much more agreeable than the prairie scenery, as some hills were always in sight, although one would never think that he was crossing the Rocky Mountains, even when at Sherman, the summit of the Cheyenne Pass. We passed through a great many snow-sheds during the day, reached Laramie at six, and passed the fort of the same name, about two miles before reaching the town. Laramie seemed to us one of the nicest little plain cities we had yet seen. We took supper further on at Rock Stream station.

JULY 30, MONDAY.

We took an early breakfast at Green River station. The scenery, as we passed on from this point, was all new to us and was very grand. The Green River cañon is a picturesque place from the beauty and extent of its erosion, and we spent the short time we had to see it on the platforms of our car enjoying it. We soon turned out of the eroded valley and went into the "bad land" district This was just as interesting in another way, for everything seemed dead now; not the slightest signs of life, and the fantastic shapes rounded out from the rock on all sides of us seemed the monuments of one vast burying-ground. We reached Carter's station at 10.30. and found our horses there, pretty stiff and thin. We at once took them out to graze and water. Scott was sick, and we left him in charge of the station-keeper's wife, while we rode over to the Fort. After a ten-mile canter we turned the corner of a butte, and the beautiful valley lay before us. The situation seems to be well chosen; the Fort is well laid out, and there is an abundant supply of both water and wood in the valley. We arrived at 2 P.M. and went to Rickard's Hotel. General Kargé had us all fixed up as soon as possible, and we set out in a body to pay our respects to the dignitaries of the place. We found General Flint, the commander, and Judge Carter very pleasant and agreeable persons. They both expressed a willingness to do all they could to further our plans. Our reception was exceedingly hospitable. The Fourth Infantry band gave us a serenade in the evening, a compliment which we appreciated very highly. Captain Merriman, Lieutenants Brown, Scott, and Adjutant True called in the evening.

JULY 31, TUESDAY.

Speir, Osborn, and Lynde went to Bridger Butte with Mr. Rickard. Potter went over to the station. Scott still unwell. M. looking up guides, and General Kargé and L. making other arrangements. We all attended the open-air concert in the evening, which we found quite a pleasant feature. There was also an inspection in the morning, but as there were only sixteen soldiers out it was not much of an affair.

AUGUST 1, WEDNESDAY.

The "bone-pickers," as we called the rest of our party, were very busy packing up their own peculiar part of the baggage and getting ready for a start. We found a guide by the name of Taylor for them. They got off about 1 P.M., and left us alone to work for ourselves. We called on Gen. Flint in the evening, and were entertained by his charming family.

AUGUST 2, THURSDAY.

Mr. Hamilton brought us in a guide this morning. We liked his looks very much. He has the very prepossessing name of "Santa Anna Joe" (or Joe Oreda), and is a Mexican of short and muscular build. We three selected our stock of utensils for camp life, and then packed everything with our instruments on two mules, which were loaned us by the commissary department. Finally everything was on board, and L. and Joe started for the St. Louis Mills, twenty miles to the south, while M. remained at the Fort. We now commenced our chain of observations from here to the mountains. The first were made this evening between these two points.

AUGUST 3, FRIDAY.

Observations were also made this morning by both of us, M. starting on after them for the St. Louis Mills. L. and Joe in the meantime amused themselves by going shooting. Came back with some birds and a jack-rabbit. When M. arrived we had our first game dinner. L. and Joe then started on again for Gilbert's Meadow. Went up the valley (which was rather thickly wooded) for three miles to Steel's Mills, then, turning to the left, crossed the West Branch of Smith's Fork, then three miles further on up a hill and through the woods till they came out in a beautiful open meadow, where the camp was pitched in a splendid grove of pine-trees near a little brook in the southwest corner. Observations were made at six, and then, while L. was fixing camp and waiting for M., Joe went out and pretty soon a rifle-shot was heard; then all was quiet, until Joe walked in a little later with a deer's heart and liver. M. came soon after, and we had the liver for supper, which we found delicious. We then built a good fire, and after rolling up in our blankets with our feet towards it, went to sleep lulled by the music of the pines. Occasionally a wolf or an owl gave variety to the dulcet tones.

AUGUST 4, SATURDAY.

We did not sleep much last night on account of the cold. We saw some deer, but they ran away before we got a chance at them. We were paid, however, in a moment for our disappointment, as two elk appeared and came down for water, and we shot both; one got away, as he was only wounded. After breakfast Joe went back to Bridger with some instructions, and left us to take care of the elk and the deer. We sent a quarter of the deer to General Flint by him. Our knives were rather dull, and we spent the morning cutting the two animals up. Then came a difficulty; we could not get the mule within fifty feet of any blood, and when we came near him with bloody hands he would rear and kick like all possessed; so we had hard work to get the deer on him; then we took him back to camp and brought out Joe's old black horse, which stood it better. After quartering our elk we found we could only manage one quarter between us, and even then it was not much fun. We carried this back and then got our dinner. Then we set about arranging our camp. By evening all was completed, and we sat down to a comfortable supper of venison. We saw more deer, but were too tired to go after them.

AUGUST 5, SUNDAY

The day was spent in reading, writing, sleeping, and eating in due proportions. We found our camp a delightful spot, and looked forward with much enjoyment to the few weeks we were to spend here. Just at evening, though, we experienced some trouble from the mosquitoes. We thought we were up too high for these pesky little fellows, but found that they would crawl under the leaves when it was cold, and thus save themselves for another time. We experienced some difficulty in our first attempts at bread-making. We also found that the ink we had with us was copying ink, and very thick at that, so we could not persuade our letters to dry at all.

AUGUST 6, MONDAY.

Joe and M. set out to climb Gilbert's Peak (we had been told we could easily), as it only seemed about six miles off. They saw, when they reached the ridge bordering the East Branch of Smith's Fork, that this valley alone was about a thousand feet deep, eight miles wide, and full of little wooded moraines; they then concluded that the best thing would be to move our camp nearer the mountains. So they looked for another camping place. Going along the ridge they came to the head-waters of the West Branch, and there found a very nice place, where they made observations and returned. L. made corresponding observations at the camp. Joe captured the bread-making secret this evening, succeeding finely.

AUGUST 7, TUESDAY.

We began to pack early this morning, and got off at eight o'clock. We followed the ridge again, and reached the chosen place at twelve. We spent the afternoon getting things to rights. We used the elk skin for a bed; found it very nice and soft, but it had the fault of letting us out of the tent at the bottom. For an hour or two the mosquitoes were fearfully thick. Our tent is made by supporting a wagon-cover over a ridge-pole, which was driven into a tree at one end and supported by a stake driven into the ground at the other. A blanket is drawn across one end and the other left open toward the camp-fire. Numerous pegs made of hard wood were driven into the softer pine-trees and served as supports for our various articles. We have very little trouble with our camp-fire. A few feet behind us there is an unlimited supply of old pine stumps, which can be cut away with a few skilful strokes of an axe, and when one is set on the camp-fire, after supper is over, it gives a splendid heat and light all night.

AUGUST 8, WEDNESDAY.

Last night it was fearfully cold; our little stream being covered with a two-inch coat of ice. We devoted the whole morning to laying out a base-line. Having chosen two open places on the long ridge which we had come over as the position for it, we levelled our stakes by the transit, and measured both by steel tape and levelling-rod (the transit having stadia wires for this purpose). We were pleased with the results, as we came within $\frac{3}{10}$ of an inch. We were forced to cut a line through a small strip of timber which separated our two open plateaus. These places were almost on a level, and were not only easily seen from all the mountains of the valley, but were beautifully marked out for us by the ring of open ground around each station. They were so plain that missing them was impossible. In the afternoon we fixed our station, No. 3, on the ridge back of the camp, on the other side of the West Branch, and thus closed our first triangle. Held a consultation in the evening, and decided on the plan of going up one side of the valley of the East Branch, and after we had gone as far as we could, to change our camp to the middle of the valley, and come down on the other side. We still mourn the mosquitoes.

AUGUST 9, THURSDAY.

M. and Joe set off with the mules up the ridge. They fixed stations Nos. 4 and 5, measuring both the triangles and the barometric height. They met an Indian, who told them that there were plenty of Shoshones, Snakes, and Bannocks in this part of the country, hunting and setting the woods on fire. L. started the meteorological journal to-day, making observations every fifteen minutes. We had broiled grouse for supper.

AUGUST 10, FRIDAY.

The same programme was followed to-day. M. and Joe set off up the ridge and fixed Nos. 6 and 7. L. continued the meteorological record every fifteen minutes during the day. We killed a two-year old buck, and took him home to camp. This addition to our store of meat proved very acceptable, as we had brought but a small portion of our bountiful supply from the other camp. The night was warm and the mos quitoes stayed late.

AUGUST 11, SATURDAY.

L. and Joe started across the valley to fix two stations on the other side (Nos. 9 and 10), in which they succeeded, but found the road very rough. They made observations for a new camp in the middle of the valley. M. made corresponding observations in the camp. The rainy season has commenced, and we expect a drenching every day. L. found plenty of rain and snow on the ridge while working there.

AUGUST 12, SUNDAY.

We turned out slowly this A.M., and as we thought that all our Indian friends had left us to go across the range, we left our camp to take care of itself, and started for Steel's Mills, a point half-way between the St. Louis Mills and Gilbert's Meadow. This was on the West Branch, so we followed it down. We found an old Indian trail and followed it till we came to a good road, which brought us, after a three miles' ride, to the Mill. We found Dick Steel there with about eight or ten men (as many more having gone off hunting and fishing). The scenes of the day were quite varied. We all sat around the camp-fire and heard stories, until the subject of shooting came up, when Joe was hauled out for exhibition. (He is, by the way, an excellent shot.) He wanted to shoot for ten dollars a side for each shot with the "old hunter," who was providing the camp with meat, but the old fellow was not at all anxious for fame, as Joe's powers had been known there for some years. After dinner they divided into two knots, to play poker. We, of course, watched the crowd Joe was in, and saw the fellow walk off with five dollars of their money by supper-time. They were nearly short of food, so we had the usual camp diet—venison, bread, coffee, and stewed dried currants for both meals. Starting at six we got back to our camp at eight, and found everything as we left it.

AUGUST 13, MONDAY.

We moved camp to-day, so we were all up bright and early. Before we went M. went to No. 1, and we observed the barometers to get the height of our base-line. Then M. and Joe started for the new camp with the mules and our utensils, while L. remained in the old camp to make another series of observations. L. then went over, and the new camp was in good shape by night-time. We found our old friends, the mosquitoes, here in large numbers, and with a good prospect of their staying all night.

AUGUST 14, TUESDAY.

M. and Joe started early for the ridge. Finished Nos. 8, 12, and 13, and joined in their triangles the point of No. 11. (This is a very precipitous point in the centre of the valley which we called Santa Anna Mount.) The scenery was remarkably fine, overlooking the upper basin of the East Branch on one side and the valley of Black's Fork on the other. They were troubled by the cold, the snow, and rain, and the electricity, which affected the transit, sung and hissed in the monument, gave repeated and severe shocks to the operator, and at one time ran in a stream from the barometer to the ground. L. was found alive, but battling with the mosquitoes; all that was to be seen of his face or body was a ring around the eyes, left for observing purposes. M. hurt his knee badly in the timber.

AUGUST 15, WEDNESDAY.

L. and Joe started off this morning, while M. did up some camp chores, and made corresponding observations. Points 14, 15, 16, and 17 were fixed, establishing some very important stations in the valley—one on the transverse axis of the range. They were also troubled by electricity, and kept from work for some time by it.

AUGUST 16, THURSDAY.

M. and Joe started up the eastern ridge to point No. 10; but on arriving there found it impossible to use the transit on account of the electricity, so putting it up in its case they went to the next peak in line and built a monument, and were then forced to retire in a furious hail-storm. To-day, we may say here by way of parenthesis, our troubles began. We found this morning one of our mules (the best one at that) had put his foreleg through the lariat-rope around his neck and this had thrown him down. Of course, after thumping around among the rocks all night, he was strangled and nearly dead when we found him in the morning. We nursed him during the day, and at one time thought he might survive, but in vain, when night came our servant was gone. Our bacon gave out, and our meat had run very low. However, there were plenty of trout, and we made out after a fashion.

AUGUST 17, FRIDAY.

L. and Joe tried hard to gain a foothold on the ridge, but had to give it up; but they got some more meat in the shape of a deer, only part of which they could bring home, as they were already loaded with instruments. It rained almost incessantly. We were very much disheartened, and talked seriously of doing other work in the way of returning and joining Fort Bridger to our system. The experiences of the morning with electricity were rather more alarming than usual. No. 18 (which we never included in our triangulation) was shattered to pieces before our eyes, when we were scarcely one hundred paces distant.

AUGUST 18, SATURDAY.

M. and Joe started once more for the same ridge, but were again disappointed by the storms. They built a fire to keep warm by, under one of the ledges, and when they saw that the rain was likely to continue, went off hunting. They succeeded in getting another deer, and brought home the best parts of it. It commenced to rain torrents just after supper, and rained all night.

AUGUST 19, SUNDAY.

We all went to the mill to-day, passing through our last camp about sunrise. We found a bear had been there after our meat that was left, but the fellow was gone, much to Joe's and our disgust. We arrived at 10.30 A.M., just in time to see Steel drive up with the wagon. There were lots of papers and a bundle of letters for both of us, and we enjoyed a regular treat, as well as distributing them to the various mill hands. Old Jimmie, the cook, made a very good dinner, with the rare additions of hot biscuit and pie. After this, the hands went after Joe to get some of their money back, but only got seventy-five cents. We held a council of war, and L. was to go to the Fort to-morrow to see General Kargé and make further arrangements. M. and Joe returned to camp.

AUGUST 20, MONDAY.

L. spent the day riding to the Fort, experiencing a very hard thunder-storm on the road; and, being the only prominent object on the open prairie, was not enchanted with the position. M. and Joe spent the day hunting and fishing (catching a great many fish), and watching the Indians, of whom we have quite a number camped near us.

AUGUST 21, TUESDAY.

L. spent the day at the Fort. He had to content himself with writing messages to General Kargé, as no one was in the Fort from our other party. M. and Joe spent the day fishing, and made themselves sick by eating too many trout. In the afternoon L. left his own horse at the Fort, and took a black one and a little mule from the herd-house, with which he reached Steel's mill safely, and staid there over night.

AUGUST 22, WEDNESDAY.

L. found, on arising, that both horse and mule had disappeared, and started in pursuit of them. He found the mule, but chased him six or seven miles before he caught him. The horse was afterward found near the camp, but would not be caught. L. started back on the mule in the afternoon; he reached camp at four o'clock, and found M. and Joe in a quiescent state—the effect of yesterday's troubles.

AUGUST 23, THURSDAY.

Joe went down to the mill for the horse this morning. L. went up around No. 11 to make some sketches and measurements, and M. staid in camp. Some physical measurements were made of the inclination of strata, the height of timber line was ascertained, and a sketch of the valley as seen from a ledge high up on the precipitous side of No. 11, from which a beautiful view was obtained, far out into the valley of Henry's Fork, and over the bad lands. Joe came back at 6 P.M., with no horse. We decided then and there that we would not be likely to get another horse up to that camp, and that we had better move to our last camp.

AUGUST 24, FRIDAY.

We were up early, and packed up everything; then M. and Joe went on ahead with the books and instruments to the other camp. L. staid behind to make observations, and then walked over to the camp. Joe went on with the mules to Steel's mill. M. and L. went off on a partly hunting and exploring trip in the afternoon. Joe came back in the evening, with an old black horse for L. to ride.

AUGUST 25, SATURDAY.

L. went over to Steel's mill, to do some writing, while M. and Joe went hunting. We did not like to say good-by to the mountains.

AUGUST 26, SUNDAY.

M. and Joe joined L. at the mill, and concerted plans for the return. We received a bundle of letters and papers as usual.

AUGUST 27, MONDAY.

M. and Joe started for the herd-house in the morning early, and observations were made between the two barometers. After dinner, they went from there to the Fort, where they made observations also. L. followed them, stopping at the same places until the time appointed for observations arrived. He also filled up the intervening time sketching in the profiles of the adjoining country for a map to show the relation between the Fort and the mountains. He arrived there in the evening. We found everybody well and glad to see us.

The next few days were spent in the pleasant company of those at the Fort, and were enjoyed very much. The Palæontologists arrived slowly, one after another, bringing a rich lot of fossils. We packed them all safely; and then, bidding good-by to our friends at the Fort, we joined the rest of the party, under Dr. Brackett, who were now at Cheyenne, awaiting our arrival. From this point the trip home was very similar to the outward one, with the exception that we passed over the Union Pacific to Omaha, and then to Chicago, where we spent Sunday. The various members of our party were left along the road at the nearest points to their homes, to which all returned with great pleasure, after an experience which will long be remembered by every one who had the honor and privilege to belong to the expedition.

CONTRIBUTIONS FROM THE E. M. MUSEUM OF GEOLOGY AND ARCHÆOLOGY OF PRINCETON COLLEGE.

BULLETIN No. 3.

I.

ON THE SKULL OF THE EOCENE RHINOCEROS, ORTHOCYNODON, AND THE RELATION OF THIS GENUS TO OTHER MEMBERS OF THE GROUP.

BY
W. B. SCOTT, PH. D.,
HENRY F. OSBORN, SC. D.,
Assistant Professors, College of New Jersey, Princeton.

II.

ON ACHÆNODON, AN EOCENE BUNODONT.

BY
HENRY F. OSBORN.

III.

OBSERVATIONS UPON THE BRAIN CASTS OF TERTIARY MAMMALS.

BY
ADAM T. BRUCE, B.A.,
Demonstrator of Comparative Anatomy, College of New Jersey.

IV.

ON DESMATOTHERIUM AND DILOPHODON, TWO NEW EOCENE LOPHIODONTS.

BY
W. B. SCOTT.

PRINCETON, N. J., MAY, 1883.

I.

ON THE SKULL OF THE EOCENE RHINOCEROS, ORTHOCYNODON, AND THE RELATION OF THIS GENUS TO OTHER MEMBERS OF THE GROUP.

W. B. SCOTT,
HENRY F. OSBORN.

PART I.—ORTHOCYNODON.

The skull of *Orthocynodon* was discovered in 1878 by one of the Princeton parties in the Bridger Beds of the Middle Eocene of Wyoming Territory. The exposure is what is known as the Washakie Basin of the Bitter Creek country. The beds were fully identified by the presence of *Palæosyops* and *Achænodon*, and by the fact that overlying them were numerous remains of the *Dinocerata*. Fragments of the appendicular skeleton were also obtained, but cannot be attributed to *Orthocynodon* with any certainty. An account of this animal was first given in the American Journal of Science and Arts, September, 1882.

Our conclusions, which are more fully given later in a discussion of the derivation of the Rhinoceros, are that *Orthocynodon*, showing relationship intermediate between *Hyrachyus* and *Amynodon*[1] of the Upper Eocene, is the earliest member of the Rhinoceros group thus far known. This relationship is indicated by all the principal characters of the teeth and skull. This genus differs from *Amynodon* principally in the canine teeth, which are erect instead of procumbent and in the pattern of the premolars. But the resemblances of these two genera to each other, and the characters in which they both differ from the *Hyracodontidæ*, on the one hand, and the *Rhinoceridæ*, on the other, justify our placing them in a new family, the *Amynodontidæ*.

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[1] We are indebted to Professor Marsh for allowing us to thoroughly examine the skull of *Amynodon* in his collection. The exposure of the mastoid portion of the periotic was a point of particular interest, which it was impossible to decide positively owing to the advanced age of the skull. The appearance of the bones, however, indicated a small exposure.

AMYNODONTIDÆ, FAM. NOV.

Rhinoceros-like animals; as far as yet known confined to the Middle and Upper Eocene; hornless; post-glenoid and post-tympanic processes do not unite below the auditory meatus; a small exposure of the mastoid portion of the periotic on the side of the skull; no post-cotyloid process on the mandible; canines and incisors present and functional in both jaws; lateral incisors usually absent; pattern of the first three upper premolars unlike the molars; pattern of the molars like that of the Rhinoceros, but with the transverse crests simple; probably four toes in front, three behind.

Genera.

AMYNODON,[1] Marsh. Generic characters: lower canines procumbent, incisors two on each side above and below, the pattern of the premolars throughout unlike that of the molars.

ORTHOCYNODON,[2] Scott and Osborn. Generic characters: lower canines erect, the third upper premolar has a low posterior crest, two incisors on each side (the lateral apparently absent), the fourth upper premolar has distinctly the molar pattern of anterior and posterior crests.

Orthocynodon antiquus. Specific characters: accessory ridges on first upper molars only, posterior crests on third upper premolars low, canines trihedral and slightly recurved,

THE SKULL OF ORTHOCYNODON.

The skull (Plate V) in the Princeton collection lacks the forward portions of the nasal and maxillary bones, so that the characters of the nasals can only be conjectured; all the upper teeth anterior to the third premolar are also wanting. A mass of matrix lying over the orbit could not be removed, so that this portion, although figured, is not positively known, nor is the position of the lachrymals ascertained. The upper portion of the occiput and the basal region of the skull are also somewhat imperfectly preserved. The posterior portion of the jaw, including the angle and condyle, belongs to the right side of the skull, while the symphysial portion belongs to the left. The forward portion of the skull is restored, after a careful study of the worn surfaces of the lower teeth and of the portions of the nasal and maxillary bones which remain.

The general character of the skull is slender and elongate with a light zygoma, extensive temporal fossa and quite a prominent sagittal crest. At first sight the skull is wholly different from that of the Rhinoceros, but a closer inspection shows all the prominent rhinocerotic features in their incipient stages. In fact, *Orthocynodon* differs from *Rhinocerus* in much the same manner that all the other Eocene types which have persisted differ from their descendants. We find a low instead of a high occiput, a sagittal crest instead of a flat cranium, a slender mandibular ramus and prominent canines.

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[1] American Journal of Science and Arts, 3d series, vol. xiv. p. 251.

[2] Ibid., vol. xxiv. p. 223. Owing to a more perfect exposure of the skull we can correct some errors in our first statement.

More in detail, the *frontals* are short, while the *parietals* are elongated. The brain-case indicates rather a long narrow brain. The temporal fossa is not as deep as in *Palæosyops*, but is extensive; posteriorly it is bounded by a slight ridge at the sides of the occiput. The sagittal crest is quite high and thin; it is extended backwards upon the *supra-occipital* so as slightly to overhang the occiput when the skull is in a horizontal position. Forwards the crest disappears in the well-rounded snout, without passing into supra-orbital ridges. Above the orbits is the fronto-nasal suture. The skull has an oval section at this portion, and the nasals begin to rise as in the modern Rhinoceros. The orbit is small, and there is probably a very slight post-orbital process; the anterior edge of the orbit is over the second molar. The limits of the *lachrymals* cannot be ascertained. They undoubtedly had a small exposure upon the face. The infra-orbital foramen is slightly anterior to the orbit.

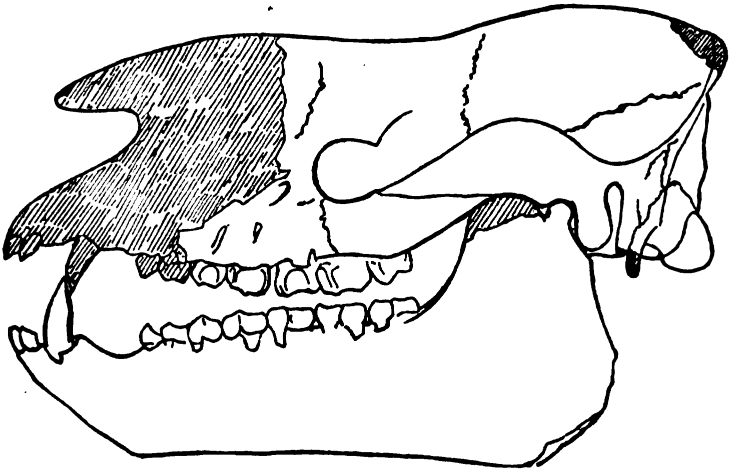

Fig. 1.—Restoration of Orthocynodon. (One fifth natural size.)

The *maxillaries* slope forwards, indicating a narrow upper jaw; the horizontal plate as well as the palatine bones are wanting. The *malars* extend to the inferior border of the orbit, forming a considerably smaller portion of the face than in the Rhinoceros. The zygomatic arch is slender as in *Aceratherium*, lacking the robust character which it has in *Palæosyops*. The external surface projects considerably beneath the orbit; posterior to this the arch is slender and narrow in vertical section, not projecting widely from the skull. The malar-squamosal articulation is not very close. The zygomatic border passes downwards into the heavy post-glenoid process. This process is deep and quite broad, and placed directly behind the condyle of the jaw. This is quite different from its light character and internal position in *Rhinocerus*. There is no pre-glenoid border. Behind this process is the wide external auditory meatus; the distinctive character of this portion of the skull is that the post-glenoid and post-tympanic processes are quite widely separated below. Behind the auditory meatus is a triangular surface composed of portions of the squamosal, the periotic and the ex-occipital bones; this surface is divided from the temporal fossa by a low ridge, and it slopes away posteriorly into the occiput. This surface offers a great contrast to the compressed space between the occiput and the temporal fossa in the Rhinoceros. The exposure of the mastoid is faintly outlined in the restoration (Fig. 1). It cannot be traced throughout with certainty owing to the close forward union with the squamosal. It is, however, quite as clear as in many of our specimens of *Hyracodon*. The resemblance of this portion of the skull to *Hyrachyus* is remarkably close. The *squamosal* ascends well upwards and backwards, forming the posterior portion of the temporal fossa. The occiput is quite narrow above and broad below; the *supra-occipital* is partially broken. The limits of the *ex-occipitals* are clearly defined; they have similar relations to those in *Rhinocerus*, sending down a rather slender par-occipital process which has a long union with the post-tympanic. The occipital condyles are very convex and projecting; they are largest in vertical diameter and directed obliquely downwards and backwards; their lateral extension is not very great. The basi-cranial region is not well defined, and it cannot be ascertained whether there was an ali-sphenoid canal.

The *lower jaw* has the typical ungulate character. The chin is shallow and sloping; the ramus is not very deep; the angle is very broad and flat, with a much elevated condyle. The symphysis is long and oblique. There are apparently two mental foramina placed beneath the canine-premolar diastema. The border of the jaw at the diastema is thin. The incisor alveolus is wanting, but the teeth are held *in situ* by the matrix; they have a nearly erect position. Marking the posterior edge of the symphysis below is a slight downward swelling. Behind the molars the superior border rises rapidly, indicating a light coronoid process. The condyle is broad and convex; it has no post-cotyloid process. Beneath it the posterior border of the jaw is recurved. The angle of the jaw is rounded and comparatively thin, wholly lacking the heavy rugose character of the angle in *Rhinocerus*.

Measurements of Skull.

	M.		M.
Total length of skull estimated, about 17 inches	.44	Length of mandibular ramus, approximate.	.36
Height of skull, including lower jaw	.23	Depth of " " below root of first molar	.065
Width of skull just below the orbit, including the malars, approximate	.16	Depth of ramus from top of condyle to lower border of angle, approximate	.175
Length of zygomatic arch from posterior surface of post glenoid process to malar maxillary suture	.17	Length of mandibular symphysis, approximate	.09

Other measurements may be taken from Plate V, which is executed accurately upon a half scale.

DENTITION OF ORTHOCYNODON.

LOWER JAW. *Incisors.* Of the lower incisors our specimen has three in position, the two median and a lateral of one side. The alveolus of the jaw is all crumbled and broken so that the number of the incisor teeth cannot be definitely determined. It certainly was not less than two, and *may* have been three, as there is an abundance of space for an additional tooth between the second incisor and the canine, the symphysis being considerably broader than in *Amynodon*, where the canines and incisors are closely crowded together.

The incisors are represented in Plate V, Figs. 1 and 4. In the former figure the left median and the front face of the right median are both seen; in Fig. 4 the summits of the two median incisors are seen.

The median incisor is the larger of the two; in shape its crown is quite similar to that of the corresponding tooth in the Tapir, but is smaller and more acute. The upper edge is like an inverted V, and not a straight line as in the Tapir. From the apex, which is truncated by attrition, a low ridge runs obliquely down the posterior face of the crown. The cingulum is very feebly marked in the anterior surface of the tooth, but is quite strong in its lateral and posterior surfaces.

The second incisor, which is too much broken to admit of accurate description, is separated from the median one by a narrow space. It has a somewhat everted conical crown. Both teeth have long, straight and simple fangs.

The lower incisors are not at all like those of *Rhinocerus* in either position or shape, being small, acute and nearly erect. Even in *Amynodon* the incisors have begun to be very much more procumbent.

The *Canine* is a very large tooth; it stands erect and is even slightly recurved, one of the most striking differences between this genus and *Amynodon*, which has the "lower canines placed nearly horizontal."[1] In the specimen before us the canine is long, pointed and somewhat everted, so that it stands somewhat outside the line of the molar series. In shape a section of the crown is somewhat trihedral, with a flat posterior surface; the other surfaces are slightly rounded. The upper portion of the posterior face is worn bare of its enamel by the action of the upper canines.

The fang is stout, sub-cylindrical and strongly recurved, running down into the jaw for nearly the entire length of the symphysis.

In *Amynodon* the canine has assumed a shape more characteristic of the Rhinoceros type, in being more compressed and having trenchant edges, while in *Orthocynodon* the only departure from the Lophiodont pattern is in the increase in size of the lower canine.

Premolars. These teeth (Fig. 3), four in number, form an unbroken series as in *Hyrachyus.* The first premolar is separated from the canine by a long diastema, and is inserted by two fangs of nearly equal size. Seen from the outer side, the tooth has a conical crown obscurely divided into two lobes by a faint ridge running obliquely down its outer face. The crown is compressed and narrow and has its anterior and posterior edges sharp and trenchant. Internally the two lobes are more apparent, the anterior fossa being very shallow and the posterior quite distinct. The very obscure cingulum is present only in the inner face. The tooth is very like the first milk-molar of *Rhinocerus indicus.*

The second premolar is much larger than the first, and, while presenting no new elements, approximates more the type of the molars. The groove separating the external lobes is more marked, the median internal crest very much more decided, and the anterior and posterior edges of the crown are raised into rudimentary crests. As a whole, the tooth is very similar in construction to the corresponding tooth of *Hyrachyus.*

The third and fourth premolars show a closer and closer approximation to the molar pattern; the lobes being more clearly defined, and the posterior lobe becoming larger than the anterior. In the third premolar the anterior crest is more feeble than in the molars, but in the fourth (the crown of this tooth is somewhat broken) there seems to be no deviation from the molar type.

The *Molars*, of which the third is missing from our specimen, need no especial description, being entirely like those of *Acera-therium*, *Hyracodon* and *Rhinocerus.* The only point that deserves mention is the comparatively small size of the anterior fossa of the first molar, and the greater size of the posterior lobe of this tooth, as compared with the more modern types.

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[1] **Marsh, Amer. Jour. Sci. and Arts, 3d ser., vol. xiv. p. 251.**

UPPER JAW. *Incisors.* One isolated tooth is preserved which probably belongs to this series. It is more distinctly acute and conical than the corresponding lower incisor. As in the latter there is an internal cingulum and a ridge running down the inner face of the crown. The edge is considerably worn.

The *Canine* is not preserved, but its presence is demonstrated by the worn posterior surface of the lower canine. The size and shape of this worn surface would seem to indicate that the upper canine was smaller than the lower, though little dependence can be placed on this.

Premolars. Of this series only the third and fourth are preserved, and the inner part of the crown of the third is badly broken. The external face of this tooth shows that the antero-external lobe is not so much reduced as in the true molars. This face is sub-quadrate in outline, but with the cutting edge shorter than the base. The ridge separating the two lobes is distinct. There seem to have been two transverse crests which may have been distinct or united in one internal lobe, but the inner part of the crown is so broken as to render either view uncertain.

The structure of the fourth premolar differentiates this genus from *Amynodon* in being constructed on essentially the same plan as the molar teeth, though with some modifications. The antero-external lobe is not so much reduced as in the molars, and there is a distinct ridge on the outer face of the hinder lobe. There are two transverse crests which are independent internally; the posterior one is, however, very low. A strong cingulum runs around the whole interior of the crown.

The *Molars* are of the typical Rhinoceros type, though simpler than in the recent or even the Miocene forms. Mr. Lydekker[1] has shown that the upper molars of the *Rhinoceridæ* may be divided into two classes; one of these, represented among recent forms by the Sumatran Rhinoceros, "is characterized by the production of the antero-external angle of the crown into a strong buttress or column, which renders the outer wall of the tooth very sinuous. . . . . The second type of molar is represented in the large living Indian rhinoceros and in the African rhinoceroses; it is characterized by the absence of the buttress, whence the external wall is approximately straight." The first of these types is the older one, and to it *Hyracodon* and *Aceratherium* (at least so far as the American species are concerned) conform. This is also true of *Orthocynodon*, which has the molars less complicated even than in *Aceratherium*. Prof. Cope[2] has called attention to the fact that in this line of Perissodactyls a further series of modifications "consists of a successive complication of the transverse crests." In the American species of *Aceratherium* this complication goes no further than the formation of a bulge (ante-crochet, Lydekker) from the anterior crest into the median valley in the first and second molars. In the European and Indian species this bulge is sometimes present; more commonly a corresponding projection from the *posterior* transverse crest (crochet, Lydekker) into the median valley is found in all the molars and some of the premolars, as is the case in the living species of Sumatra, India and Africa. In *Orthocynodon* the projection from the anterior crest is present only in the first molar, the crests of the other two being perfectly simple.

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[1] Mem. Geol. Survey of India, Palæontol. Ind., ser. x., vol. ii. p. 8.

[2] Bulletin U. S. Geolog. Survey, vol. v. no. 2, p. 231.

Another complication found in the recent forms is seen in the great elevation of the cingulum on the posterior face of the molars so as to form accessory crests, and when the tooth is somewhat worn down these are seen to enclose small fossæ. This is seen in a less degree in *Aceratherium* and *Hyracodon*, and the beginnings of it in *Orthocynodon*, in which form the cingulum of the first molar shows a prominence at the hinder surface of the crown. This is not seen in the other molars. Thus in all respects the first molar shows a closer approximation to the more recent and complex kinds of teeth than do the others.

The second molar is, as is usual in this group, much the largest of the series; it is the typical Rhinoceros molar without any accessory complications.

The third molar shows some interesting peculiarities. Prof. Cope[1] has noted that in *Aceratherium* and the more recent forms the posterior crest is confluent with the external wall of the tooth, while in *Hyracodon* the posterior crest is distinct from the outer wall, which, as in the Lophiodonts, is continued well back of the posterior crest. In *Orthocynodon* there is, as we should naturally expect, a more primitive condition even than in *Hyracodon;* the outer wall is produced much beyond the posterior crest, so that a wide and deep fossa is enclosed between the two. At the posterior angle of the cutting edge the wall and the crest are connate; from this point the former slopes upwards and backwards. (Plate V, Fig. 2).

The form of the crown is thus a step towards *Hyrachyus* as compared with the Miocene forms.

The molar teeth came into use very much as in *Rhinocerus.* The last molar shows no wear at all, while the other two, especially the first, are very much worn down.

Regarded as a whole, the dentition of *Orthocynodon* is strictly intermediate between the Lophiodonts of the Eocene and the Aceratheria and Hyracodonts of the Miocenè, though, curiously enough, it shows a greater specialization of the premolars than is seen in *Amynodon.*

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[1] Loc. cit.

Measurements.

Lower Jaw.	M.
Transverse diameter of median incisor....	.009
Antero-posterior " " " "	.011
Transverse " " 2d "	.008
Distance between 1st and 2d incisors.......	.006
" " 2d incisor and canine	.009
(There was thus abundance of space for a third incisor.)	
Vertical height of crown of *canine*	.035
Transverse diameter of crown of canine at base (approx.)..........................	.020
Fore and aft diam. of crown of canine at base	.015
Length of worn surface, measured from apex..................................	.013
Length of diastema between canine and premolars................................	.040
Length of entire molar series (without last molar)..................................	.165
Length of premolar series.................	.080
Fore and aft diameter of 1st *premolar*.....	.013
Transverse " " " "	.009
Fore and aft " " 2d "	.019
Transverse diameter of 2d *premolar*......	.015
Fore and aft " " 3d "	.023
Transverse " " " "	
Fore and aft " " 4th "	.029
Transverse " " " "	.017
Fore and aft " " 1st *molar*..........	.037
Transverse " " " "	.024
Fore and aft " " 2d "	.044
Transverse " " " "	
Upper Jaw.	
Fore and aft diameter of 3d *premolar*.....	.019
" " " " " 4th "	.022
Transverse " " " "	.033
Length of true molar series..................	.104
Fore and aft diameter of 1st *molar*.........	.037
Transverse " " " "	.037
Fore and aft " " 2d "	.045
Transverse " " " "	.037
Fore and aft " " 3d "	.028
Transverse " " " "	.030

PART II.—DERIVATION OF THE RHINOCEROS GROUP.

The Rhinoceros group is at present represented by three genera, perhaps four, which are confined to the Oriental and Ethiopian regions. Formerly, however, it had a much wider range and was very much richer in genera and species. Remains of various members of the series have been found all over Europe, Asia and North America, and the origin of this line has been pushed further and further back in time by successive discoveries. The earliest members of the series have been found in the Upper and Middle Eocene of Utah and Wyoming, the former deposits yielding *Amynodon*, and the latter *Orthocynodon.*

The origin of the Rhinoceros line from Eocene Tapiroids was first suggested by Prof. Marsh,[1] and has been abundantly confirmed by subsequent investigations. Gaudry's[2] view that *Palæotherium* is to be regarded as the ancestral type is beset with many difficulties, and is sufficiently disposed of by the fact that at, or even before, the time when *Palæotherium* appeared in Europe unmistakable Rhinoceroses were already living in America.

In the Lophiodont genus *Hyrachyus* of the Eocene we have the common ancestor of no less than four distinct lines of Perissodactyls, two of which, the Rhinoceros and Tapir, are still living, and two, the *Hyracodon* and *Diceratherium* lines, are extinct. The discovery of *Orthocynodon* and *Desmatotherium*[1] throws a great deal of light upon the relationships of these various forms, and it is to be hoped that future discoveries will clear them up perfectly.

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[1] Introd. and Success. of Vert. Life in America, Am. Journ. Sci. and Arts, 3d ser., vol. xiv. p. 361.

[2] Les Enchaînements du Monde Animal, ch. iii.

THE RHINOCEROS SERIES.

The first steps of the change from *Hyrachyus* towards *Rhinocerus* may be inferred from a careful comparison of *Hyracodon*, *Amynodon* and *Orthocynodon*, thus determining what features are common to the three. In this way we can in a measure reconstruct the common ancestor of these genera, which came one step further down than *Hyrachyus*.

The first change seems to have been the transformation of the molar teeth from the Lophiodont to the Rhinoceros type by the reduction of the antero-external lobe and greater obliquity of the transverse crests in the upper molars. In the lower molars the crests became more curved, less directly transverse and more closely united at their outer edges, while at the same time the descending ridge from the anterior crest, so well shown in some species of *Hyrachyus*, became still further developed, giving the characteristic double crescentoid pattern of the Rhinoceros molar. A worn molar of *Hyrachyus* shows the essential unity of the two patterns very distinctly.

It is also possible that in this hypothetical form the premolars underwent preliminary changes much as in *Desmatotherium*, but from the uncertainty as to the exact form of these teeth in *Amynodon* this cannot be stated definitely. In other respects the features common to the three genera under discussion are those possessed also by *Hyrachyus*, namely, (1) the presence of canine and incisor teeth in both jaws; (2) the extension of the external wall of the last upper molar beyond the posterior transverse crest;[2] (3) the exposure of the periotic bone on the surface of the skull; (4) the sagittal crest; (5) the transverse extension of the post-glenoid process; (6) the wide separation of the post-glenoid and post-tympanic processes; (7) the absence of a post-cotyloid process on the mandible; (8) the absence of any special thickening of the edge of the ascending mandibular ramus.

All of these characters must be supposed to be present in our hypothetical genus, and furthermore it almost certainly had four digits in the manus and three in the pes. From this point the two lines diverge, the *Amynodontidæ* passing to the *Aceratheria* of the Miocene, and the other line, possibly through *Triplopus*, to the Hyracodonts of the same formation.

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[1] See fourth paper of this Bulletin.

[2] See Cope, loc. cit. p. 234.

SKULL. The *Amynodontidæ* retain many Lophiodont characters, deviating markedly from the Rhinoceros type. Besides the points of resemblance to *Hyrachyus* already mentioned there remain other features of importance. The skull is long and narrow; the face is especially long as compared with that of *Aceratherium.* In the latter the edge of the orbit is directly over the middle of the first molar; in *Orthocynodon* it is over the middle of the second molar, a considerable difference at that point. Altogether the face, as nearly as we can judge from our specimen, forms very nearly half the length of the skull. The posterior part of the cranium projects proportionately further beyond the root of the zygomatic process, so that on the whole the skull is both longer and narrower relatively than in the *Rhinoceridæ.* The long and high sagittal crest is another Lophiodont feature that has been progressively obliterated as the line approaches the more modern forms. In *Aceratherium* the crest is much shorter, the broad surface of the skull extending well over the temporal fossæ. In *Aphelops* the crest is still further reduced, and through its entire length is divided into two ridges by a narrow intervening space. In the modern forms there is no sagittal crest at all, the whole upper surface of the head being very broad.

Another progressive change in the shape of the skull is seen in the rise of the occipital and parietal regions above the frontal. In *Orthocynodon* the upper line of the skull is not very far from straight, the sagittal crest curves slightly upwards from the level of the frontals, giving the cranium a shape very like that of *Hyrachyus.* In *Amynodon* the shape is more like that of the Tapir, while in *Aceratherium* there is a decided rise in the parietal region; a feature which is much plainer in *Aphelops,* and still more so in *Rhinocerus.*

One of the most characteristic differences between the Lophiodont and Rhinoceros types of skulls is the presence of the periotic on the surface in the former, and its absence from the surface in the latter. This bone is plainly visible in the side wall of the skull of *Orthocynodon;* it is probably present also in *Amynodon.* Prof. Cope[1] has also demonstrated its presence in *Hyracodon.* In correspondence with this arrangement we find in these three genera that this portion of the skull is very like that of *Hyrachyus,* being rather broad and triangular, while in *Aceratherium* and more recent genera the disappearance of the periotic from the surface is accompanied by a narrowing of this region into a mere ridge.

Another series of changes in the Rhinoceros skull is one emphasized by Prof. Cope in the pamphlet already quoted; namely, the relations between the post-glenoid and post-tympanic processes of the squamosal. In the Lophiodonts and Tapirs these processes are widely separated, leaving the auditory meatus open below; a state of things which we also find in the Eocene *Amynodontidæ*. In *Aceratherium* the two processes approach each other, and in one of our specimens from Dakota are almost in contact. In *Aphelops* they touch each other, and in *Rhinoceros* they are co-ossified. *Ceratorhinus* and *Atelodus*, which are persistent Miocene genera, have the meatus still open. *Hyracodon* agrees with the other Miocene types in having these processes widely separated.

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[1] Loc. cit.

Other progressive modifications, as the change of the occipital condyles from projecting to sessile, the conversion of the broad and transversely directed post-glenoid process into a styliform shape, the appearance and increase of the post-cotyloid process, the thickening of the posterior edge of the ascending mandibular ramus, might be followed out in the same way, each one gradually leading up to the modern forms, in all of which respects *Orthocynodon* represents the first stage.

The BRAIN likewise indicates a continual advance, at least in size. In *Hyrachyus* there was quite a large brain for an Eocene mammal. The hemispheres were well developed and rounded, though little convoluted (as far as can be judged from a cranial cast); the olfactory lobes were large, and the cerebellum was lodged in a very distinct fossa. Of the details of the brain in *Orthocynodon* we know nothing, but judging from the general shape of the cranium, it appears to have been somewhat longer and narrower than in the Lophiodonts. Compared with the Eocene Rhinoceroses, *Aceratherium* had a much higher type of brain. The hemispheres are much larger, both in proportion to the skull and to the cerebellum; they are well convoluted, broad, rounded and somewhat depressed, and seem to have slightly overlapped the cerebellum. The olfactory lobes are considerably reduced in size. This brain is not unlike that of the modern species.

DENTITION. In the dentition the steps of progressive modification are very clearly seen. In *Orthocynodon* the only change from the Lophiodonts, besides the transformation of the molar teeth, is the enlargement of the lower canines and perhaps the loss of one pair of lower incisors. In *Amynodon* the canines are procumbent and compressed, and, "taken in connection with the rest of the anterior dentition, they prove conclusively that the large lower teeth, usually regarded as incisors in *Aceratherium* and many other members of the Rhinoceros family, are really canines" (Marsh[1]). This view of the homologies of these teeth is completely confirmed by their position in the Bridger genus, which is like that of all the Eocene Tapiroids. Their compressed shape and procumbent position in *Amynodon* give us the second step towards the Rhinoceros form of dentition. The loss of opposition consequent upon this procumbency of the lower teeth must be regarded as the cause of the atrophy of the upper canines. A similar process may be observed in the Tapir, where the opposition of the slightly procumbent lower canine has caused a great development of the upper lateral incisor. In consequence of this arrangement the upper canine and lower lateral incisor have both experienced a great reduction in size.

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[1] Am. Journ. Sci. and Arts, 3d ser., vol. xiv. p. 252.

The increase in size of the upper incisor in *Aceratherium* and the modern forms seems to be due to the opposition of the lower canines. In the Eocene forms this process had scarcely begun, and so we see no especial modifications of these teeth in the *Amynodontidæ*.

THE SKELETON. The clear indications of advancing differentiation which are thus afforded by the skull, the brain and the dentition may be further extended and confirmed by a study of the skeleton.

In part this has already been done by Prof. Cope, but the comparison may be somewhat further extended.

Of the skeleton of *Orthocynodon* we know nothing with certainty, but that of *Aceratherium* still retains many features of its Lophiodont ancestry which are of much interest. Both this form and its Upper Eocene predecessor, *Amynodon*, had four digits in the manus and three in the pes. In the European species of *Aceratherium* the fifth digit is extremely small and functionless, evidently about to disappear. The whole skeleton in this genus is lighter, smaller and less specialized than in any of the living genera. The neck is longer and less massive; the axis has a particularly long centrum, its neural spine is lighter, in correspondence with the less massive head, and, as in the Lophiodonts, the spine is produced more backwards than forwards. Vertebræ of the other regions bear out the same conclusion. The limbs show similar relations, the bones being more slender and without that great development of the various processes which gives the bones of modern Rhinoceroses their characteristic appearance. The humerus and fore-arm bones are much stouter than in *Hyrachyus*, much more slender than in living forms. The carpus was expanded laterally, but was of a less antero-posterior diameter than in the Rhinoceros.

The metapodial bones of the Eocene Tapiroids are of two types: those of the *Chalicotheridæ* are short and stout, while the *Lophiodontidæ* have them long and slender. *Aceratherium* has these bones of the Lophiodont type, but they have become much heavier, and yet not so stout as in *Aphelops*, *Ceratorhinus* or *Rhinocerus*. There is less difference in size between the median and lateral metapodials than in these genera, and as a whole the foot is rather long and narrow. The astragalus of *Acera-*

therium is characteristically Rhinoceros-like, but it has a somewhat longer neck and a smaller facet for the cuboid.

As a whole, then, the skeleton of *Aceratherium* may be said to be intermediate between that of the Lophiodonts and that of the Rhinoceroses, though plainly with closer affinities to the latter.

It seems, therefore, that the derivation of the Rhinoceros line from Lophiodont forms, as first suggested by Prof. Marsh, may be regarded as established; and further, that, according to all present evidence, the group originated in North America. The earliest known European members of the series are the Miocene species of *Aceratherium*, which seem to have migrated from America, and there to have given rise to the horned genera. The only horned Rhinoceroses which have so far been found in America belong to the peculiar genus *Diceratherium*. It is possible that the genus *Aphelops* also migrated to the Old World, and was there ancestral to the horned types; but the evidence so far obtained goes rather to show that *Aphelops* was not in this line, but that the loss of the fifth digit of the manus took place independently in Europe and America, occurring in the former continent simultaneously with the development of dermal horns, and so giving rise to the genus *Ceratorhinus*. This genus has the auditory meatus open below, and has a type of molar teeth but little more complex than those of *Aceratherium*.

From *Ceratorhinus* were probably derived, as suggested by Prof. Cope, the two other living genera, *Rhinocerus* and *Atelodus:* the former by the closure and co-ossification of the auditory meatus and the development of a more complex type of molars; the latter by the loss of all canines and incisors. It seems likely that the development of the second horn in *Ceratorhinus* took place subsequent to the branching off of the genus *Rhinocerus*.

Atelodus appeared in the Upper Miocene of Greece, whence so much of the fauna of modern Africa was derived. *Rhinocerus* appears for the first time in the Upper Miocene of India, and still persists there. Prof. Cope[1] has described a new genus of Loup Fork hornless Rhinoceroses, which he calls *Peraceras*, and which he regards as the ancestral type of the African *Atelodus*. But it seems to us that his former view, quoted above, is the more probable one. *Peraceras* resembles *Atelodus* in the absence of all canines and incisors, but it was hornless and had the post-glenoid and post-tympanic processes in contact though not co-ossified. Then contemporary with, or perhaps even anterior to, this hornless form was the *A. pachygnathus* of Greece with both horns already developed.

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[1] Am. Naturalist, 1880, p. 540.

It seems to us, therefore, more likely that the Old World forms were derived from *Aceratherium* through *Ceratorhinus*, while *Aphelops* and *Peraceras* were the American forms derived likewise from *Aceratherium*. This view does not preclude the possibility of a migration of *Aphelops* from America, and it would not be surprising if such were found to be the case. Perhaps the genus is still living, and may be represented by the *R. inermis* of Lesson.[1] The view here maintained is simply that *Aphelops* cannot be regarded as ancestral to any of the modern genera.

This conclusion is confirmed by a comparison of the molar teeth of the species from America with those of the Old World forms. In the American *Aceratheria* the only complication of these teeth consists in the bulge projecting from the *anterior* transverse crest into the median valley. This is also found in some of the European forms, though the latter, as well as those of India, agree with the modern species in having these accessories developed on the *posterior* transverse crests. *Aphelops* has something of both, while the modern species (at least as many as we have had the opportunity of examining) agree with most of the Old World species of *Aceratherium* in having the anterior crests of the molars simple.

THE HYRACODON SERIES.

This most interesting offshoot of the Rhinoceros line has long been imperfectly known. Professors Leidy, Cope and Marsh have given us valuable hints with regard to its structure, but there still remains much to be done in this respect.

Among the collections made by the Princeton Expedition of 1882 was a large number of *Hyracodon* specimens, including an almost complete skeleton. This material serves to throw much light upon the structure of this animal and its place in the zoological system.

Hyracodon was a slender, long-limbed and slightly built animal with a long neck and delicate head. Its proportions were those of a Horse rather than of a Rhinoceros. It is evidently very closely related to *Hyrachyus* (as was suggested by Prof. Marsh from the character of the molar teeth), and many parts of its skeleton were almost identical with those of the latter genus.

In its general features the *skull* is of the Rhinoceros type, but, as we have already seen, there are many points of resemblance to the *Hyrachyus* skull; the long sagittal crest, the weak nasal bones, the widely open auditory meatus, the shape of the post-glenoid process, the exposure of the periotic on the surface of the skull, and the absence of any post-cotyloid process, as well as the shape of the mandible and the presence of a full set of canine and incisor teeth in both jaws, are all very strong evidences of the Lophiodont ancestry. While the molars and premolars are of the same pattern, the construction of the upper molars, and especially of the last one, reminds one strongly of the Eocene progenitors. Even the accessory ridge, which in *Hyracodon* projects from the outer wall of the tooth into the median valley, may be seen in some species of *Hyrachyus.*

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[1] See Cope, Bull. U. S. Geolog. Survey, vol. v. no. 2, p. 237.

When we come to examine the skeleton of the trunk and limbs we find that here the Rhinoceros characteristics are less distinct than in the skull and dentition, while the Lophiodont affinities are very clearly observable, and in addition there are a number of peculiarities not to be met with in either of the groups mentioned.

The neck is very slender and elongate; the cervical vertebræ are strongly opisthocœlous, and those behind the axis have broad flat zygapophyses without neural spines. The transverse processes were perforated. The length and flexibility of the neck is one of the strongest contrasts between *Hyracodon* and the Rhinoceroses; it is even considerably longer than in *Hyrachyus.* The thoracic vertebræ are also opisthocœlous, with deep, rounded, rib facets, and long, light and compressed neural spines. There is a lightness of structure about them very different from the heavy, solid vertebræ of the Rhinoceroses, and more like those of the Lophiodonts. The lumbar vertebræ seem to have been six or seven in number. The anterior ones are compressed and the posterior depressed; the spines are short and rather light. The sacrum is not unlike that of the Rhinoceros, with very depressed centra. As in this form, there is a facet on the transverse process of the first sacral for a corresponding one on that of the last lumbar. None of the caudal vertebræ are preserved.

The *limbs* of *Hyracodon* show even more striking divergences from the Rhinoceros type than does the trunk. One is immediately impressed with their lightness and length. The humerus is much like the corresponding bone in the Tapir and *Hyrachyus*, but of lighter construction; the head is very flat, about the same shape as in the Rhinoceros; the tuberosities are large and enclose a deep bicipital groove betwen them; but neither they nor the deltoid ridge are developed to anything like the extent that is seen in the Rhinoceroses. The shaft is slender, the trochlea rather narrow, and the condyles insignificant. The proximal end of the radius covers the entire width and most of the thickness of the trochlea, the ulna bearing very little of the weight. The shaft of the radius is slender, compressed and curved; its lower end is expanded for the reception of the scaphoid and lunar; but these faces are very small and narrow as compared with the same in *Hyrachyus*. The shaft of the ulna is very slight and is closely applied to the radius, though not co-ossified with it; its distal end is very narrow and articulates with the cuneiform only.

The *manus* as a whole is strikingly long and narrow, the carpus being especially contracted in width. Compared with the carpus of *Hyrachyus* the bones of the proximal row are all much narrower and vertically elongated. In the distal row the magnum is proportionately a much larger bone, following the relative increase of the middle digit, while the unciform has become very much smaller owing to the loss of the fifth digit, and the great reduction in size of the fourth. In like manner the trapezoid is much narrower, owing to the reduction of the second metacarpal. A trapezium was also present, but does not seem to have reached the scaphoid. As Prof. Marsh has shown, all the feet are tridactyle. The metacarpals are very elongate, and the third one is proportionately better developed than in *Hyrachyus*, but has very much the same shape as in that genus; the second and fourth metacarpals are very slender; they lie somewhat behind the third and are closely applied to it throughout their entire length, giving a very narrow and compact foot. The second metacarpal touches the magnum by a very small facet indeed, and differs in this respect very markedly from *Hyrachyus*, the Tapir, *Aceratherium* and the Rhinoceros. This state of things is also seen in the carpus of *Anchitherium*, and indeed the manus as a whole is not very unlike that of the American species of *Anchitherium*, in which the lateral metacarpals are less reduced in size than in the European species. The phalanges of *Hyracodon* are long and narrow, the ungual phalanges being especially so. They are not at all like the broad, flat unguals of *Hyrachyus*, but are narrow and pointed, somewhat like those of an antelope in general shape. The median unguals are missing from our specimens; probably they were broader than the lateral ones.

In the *hind limb* we find a similar series of modifications. As far as can be judged from our specimens, the pelvis was much like that of *Hyrachyus*, with the ilia less expanded than in the Tapir or Rhinoceros. The former is very much like that of *Hyrachyus*, but a little stouter; it is a long, slender bone, much lighter in construction than that of the Tapir or Rhinoceros; the head is set on a more decided neck and is more nearly spherical than in these forms. All three trochanters are well shown, but they have not the massiveness of these processes in Rhinoceroses. The construction of the trochlea and condyles is like that in *Hyrachyus*. The tibia is quite like that of the last-named genus, but a little stouter, though much more slender than in the Rhinoceros, Tapir or *Aceratherium*. The spine and cnemial crest are much less marked than in the three last-named genera, but heavier than in *Hyrachyus.*

The *pes* is narrow and compact like the manus. The astragalus is very like that of *Hyrachyus*, but narrower and with a shorter neck. The cuboid facet is very small, a striking contrast to the Rhinoceros type of astragalus, and a resemblance to the Lophiodont and *Anchitherium* types. The calcaneum is a little stouter and heavier than in *Hyrachyus.* The cuneiforms were all free. The metatarsals are very similar to the metacarpals, the median one being flat and straight, as well as slender and elongate; the two lateral ones are much reduced in thickness, and lie somewhat posterior to the plane of the median.

It will be evident from the foregoing description that *Hyracodon* was a very different animal from any other member of the Rhinoceros series, being a lightly built, slender, running animal. In short, it was a cursorial Rhinoceros, and all its modifications went towards adapting it to swift locomotion, as is seen in the long neck, the delicate limbs and the elongated, narrow feet. The reduction of the lateral metapodials indicates that the animal was not an inhabitant of marshes and jungles, and, as it was entirely devoid of weapons of defence, its only means of escape from its enemies lay in flight. One can hardly help believing that, had this line persisted, it would have resulted in a unidigital type, just as the tridactyle *Anchitherium* of the Miocene has terminated in the Horse.

As yet we do not know of any forms intermediate between *Hyracodon* and *Hyrachyus.* Possibly such a form may be found in the genus *Triplopus* (Cope). This animal resembled *Hyrachyus* in its dentition and skeleton, except that it had only three digits in the manus. But we have seen reason to believe that there was a common ancestral form for the three Rhinoceros lines, which had four digits in the manus and molar teeth of the Rhinoceros pattern. This reduction of the fifth digit can of itself hardly be regarded as any sign of direct relationship, as we find it taking place independently in so many different groups. We do not, therefore, regard it as probable that *Triplopus* stood in any direct genetic relation to *Hyracodon.*

THE DICERATHERIUM SERIES.

The third line of the Rhinoceros series consists of the very peculiar and interesting genera, *Colonoceras* and *Diceratherium*, of Prof. Marsh. The former differs from *Hyrachyus* only in the possession of a pair of rudimentary horn-cores placed transversely on the nasal bones; the latter is a large Rhinoceros with a pair of transversely placed nasal horns. It is very difficult to believe that this line, comprising the only horned Rhinoceros yet found in America, arose and acquired all the Rhinoceros characters of dentition and skeleton entirely independently of the line which passed through *Amynodon* and *Aceratherium.* It is possible that *Orthocynodon* may belong in this two-horned series rather than in the other; a supposition which finds support in the character of the molar teeth, which are closely alike in the two genera. But until the nasal bones of the Eocene genus are found this point must be left in doubt. Two other suppositions are possible with regard to this question:

(1) That *Colonoceras* is the ancestor of all the Rhinoceros lines, the nasal horns persisting only in the *Diceratherium* series and becoming atrophied in the others.

(2) That the transversely placed nasal horns arose independently in *Diceratherium* and *Colonoceras.* Of these two explanations the former seems the more probable, yet we cannot decide between them until further material is obtained. But if we are shut up to the alternative between the second explanation and the entirely independent origin of the hornless and transversely horned series, it must be admitted that it is far more probable that horns arose independently in *Colonoceras* and *Diceratherium* than that the latter should have acquired the characteristics of the Rhinoceros skull, skeleton and dentition, without any connection with the other series to which its structure closely allies it. At all events, the *Diceratherium* line seems to have diverged from the main stock before the appearance of the hornless *Amynodon.*

It is to be hoped that future discoveries will clear up these obscure problems, a solution of which the materials at present known will not enable us to offer.

The table on the following page will perhaps serve to make our views on the inter-relations of these various groups somewhat more intelligible. In several respects it will be found to agree with that already published by Prof. Cope.

In conclusion a few words as to the generic names that have been repeatedly used in this paper. Subsequent discoveries have made it necessary to revise Prof. Cope's excellent table[1] of the genera of this group, some of which must be suppressed and some new ones are to be added.

Mr. Lydekker[2] has shown that the genus *Zalabis* (Cope) was established on a misunderstanding and must be dropped, but we cannot agree with this author in uniting *Aceratherium* and *Aphelops.* The fact that the number of toes cannot always be ascertained is certainly no reason for this union; any such system would at once throw scientific nomenclature into the direst confusion. Mr. Lydekker also concludes from *plaster casts* that the auditory meatus is closed below in *Aceratherium.* The figures

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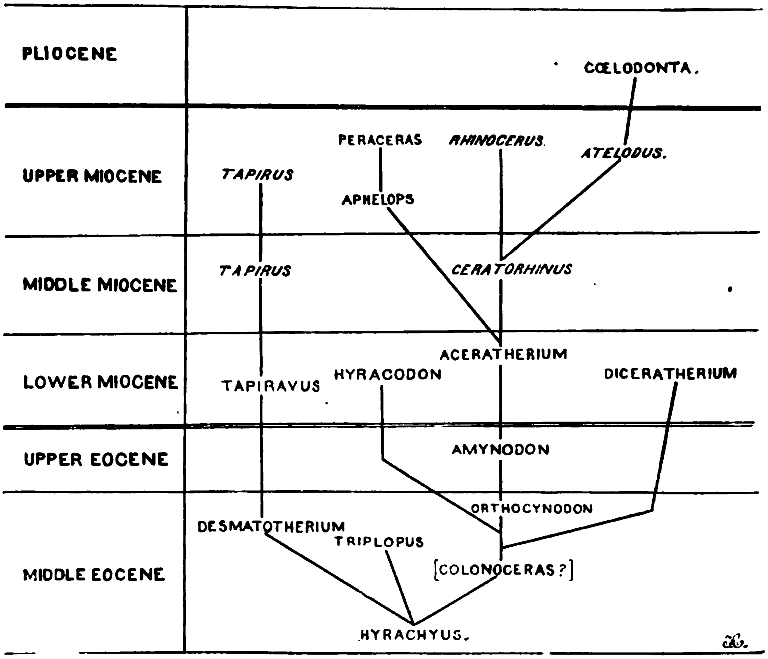
[1] Amer. Nat., 1879, p. 771.

[2] Palæontologia Indica, ser. x. vol. ii.



(*Names in italics are those of genera still living.*)

of Gaudry, Pictet and De Blainville show the meatus open, as is certainly the case in all the American species.

We also think it better to preserve the generic names that have been given to the three living types of Rhinoceroses, as it seems to us that their differences entitle them to such separation.

The writers wish to express their indebtedness to Curator Franklin C. Hill, for his valuable assistance in the preparing and mounting of the fossils described in this and the following papers.

II.

ACHÆNODON, AN EOCENE BUNODONT.

HENRY F. OSBORN.

Achænodon is probably the oldest of the Pig family which has as yet been discovered. It is thus far known only by the skull and lower jaw. The structure of these parts relates the animal with *Entelodon* and *Tetraconodon*[1] among the *Suina Bunodonta*. The general appearance and character of the skull are, however, much less like those of an Ungulate than like those of a large Carnivore.

History of the Genus. The mandible of *Achænodon* was discovered by Professor Cope in 1872;[2] he distinguished it from *Entelodon*,[3] which Leidy had previously found in the Dakota Miocene, by the fact that it had a strong posterior lobe on the last lower molar. He left the number of premolars uncertain. Professor Marsh in 1876 found the complete lower jaw of a similar animal, which he referred to a new genus, *Parahyus*.[4] He noticed the likeness to *Entelodon*, distinguishing the genus by the fifth lobe of the posterior lower molar, also by the fact that there were but three premolars. The mandible of the skull in the Princeton collection agrees with each of these descriptions, although the number of premolars is somewhat doubtful.

With our present knowledge the genus *Achænodon* cannot be clearly distinguished from *Tetraconodon* except by the presence of a few minor tubercles upon the slopes of the molar cusps in the latter genus. The resemblance between the premolars, with their high conical crowns, is striking, and both genera agree in possessing the fifth lobe on the last lower molar.

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[1] Memoirs of the Geological Survey of India: Palæontology, ser. x. vol. i.—Lydekker.

[2] U. S. Geol. Surv. of the Territories, 1873, p. 456.

[3] In regard to the use of the generic name *Entelodon* in preference to *Elotherium*, see Kowalewsky, Palæontographica, xxii. p. 415. Leidy has employed the latter name; Kowalewsky shows that the former has the precedence.

[4] Am. Journ. Science and Arts, 3d series, vol. xii. p. 402.

The specimen in the Princeton collection consists of the greater portion of the skull and the right mandibular ramus. It was obtained by the Expedition of 1878 at the bottom of the Bridger Beds (Middle Eocene) of Wyoming, and was thus coeval with *Uintatherium*, *Hyrachyus*, *Palæosyops*, *Orthocynodon*, and other Ungulates of this period:

GENERIC CHARACTERS.

Dental formula: $i.\ \frac{3}{3},\ c.\ \frac{1}{1},\ pm.\ \frac{3}{3}$ or $\frac{4}{4},\ m.\ \frac{3}{3}$.

The last lower molar has a fifth fang and posterior lobe; the other molars are of the Bunodont type with four simple cusps; the premolars have high conical crowns; the incisors vary in size—in some adults the lateral incisors may be wanting; the glenoid fossa is deep and has a wide anterior border.

Several of these characters distinguish *Achænodon* from *Entelodon*. The species[1] of this genus may be doubtfully stated as follows: *Achænodon insolens*, Cope. Lower incisors three in number, subequal in size; probably four lower premolars, the anterior being rudimentary.

Achænodon (*Parahyus*) *vagus*,[2] Marsh. A small species. Lower incisors subequal in size; three lower premolars.

Achænodon robustus, Osborn. A large species. Median and lateral incisors rudimentary or wanting; premolars three or four; accessory tubercle upon postero-internal cusp of last superior molar.

ACHÆNODON ROBUSTUS.

DESCRIPTION OF THE SKULL.

The *Skull* (Plate VI) is about eighteen inches long and, including the lower jaw, about ten inches deep. It is thus broad and deep in proportion to its length; the facial and cranial regions are in about equal proportions and arch upwards posteriorly. The brain-case is small, but the zygomatic arches are broad and strong, and the occiput is rather high and narrow in proportion.

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[1] Professors Marsh and Cope have both kindly allowed an examination of their specimens.

[2] Prof. Cope is inclined to consider *Parahyus* as a genus distinct from *Achænodon*, from the fact that it has but three premolars; but from the uncertainty as to the number of premolars in *Achænodon*, and the close agreement of the lower teeth in other particulars, it seems better to retain the single generic name at present.

The zygoma arches widely outwards from the side of the ear region, then turns abruptly forwards, ascending slightly towards the orbit. The orbit is small, placed midway between the anterior end of the canine and the post-glenoid process. It is directed slightly forwards and upwards. It is uncertain whether the orbit was completely surrounded by bone. The post-orbital processes of the malar and frontal are strong, and indicate that the post-orbital ring was complete. There are slight supra-orbital rugosities.

On the upper surface of the skull the supra-orbital ridges converging form a short wide V. They unite in a sagittal crest which arches upwards and backwards; it recalls the *Palæosyops* crest, except that it forms a comparatively thin edge. Important characters are found at the back of the skull, which unfortunately is somewhat distorted. The occiput rises obliquely backwards; it is broad and quite deeply concave, suggesting the Pig, although somewhat lower and broader. The *basi-occipital* bones and occipital condyles are wanting as well as the *basi-* and *pre-sphenoids.* One of the most exceptional features of the skull is the shape of the glenoid cavity (see Fig. 7: 2); it is about three inches broad, with well-raised anterior and posterior margins; it is therefore, like that of the Bear, quite deeply concave in fore and aft section, and plane in transverse. The post- and pre-glenoid margins are broad, not narrow, and tubercular as in the Peccary. Returning to the facial region, we find that the limits of the *lachrymals* extend some distance upon the face; an important character. The union of the *malar* and *squamosal* is well defined; the latter is nearly flat on its lower surface, with a rugose border for the mandibular muscles, and curving downwards posteriorly; anteriorly the malar extends about half way up beneath the orbit, forming a small portion of the face.

The *maxillaries* are short, rounding inwards and perforated by the infra-orbital foramen immediately behind the canine. The *nasals* are much broken and distorted in our specimen; the forward portion is wanting.

The *lower jaw* is in fine preservation. The ramus is long in proportion to its depth, arching slightly downwards and thickening beneath the molars. There is a slight tuberosity beneath the first premolar; above this is the mental foramen. The condyle is over two inches broad and well raised above the level of the molars. The upper margin of the jaw sinks and then rises an inch and a half, forming the coronoid process; from the forward portion of the coronoid a strong flange passes down the external face of the ramus. The angle has a gently rounded and rugose border, with a deep fossa for the masseter muscle, and is completely overhung by the condyle. The symphysis is oblique and long, extending back to a point beneath the second premolar.

Measurements.

Skull.	M.
Distance from post-glenoid process to anterior end of canine	.31
Anterior edge of orbit to anterior end of canine	.15
Diameter of orbit	.04
Distance between zygoma and side of skull (3½ inches)	.087
Width of glenoid cavity, transverse	.08
Depth between glenoid ridges	.015
Estimated height of skull above last molar (5¼ inches)	.15
Approximate length of skull (about 18 inches)	.46
Mandible.	
Depth of ramus below posterior molar	.089
Distance from angle to anterior end of symphysis (about 14 inches)	.37
Height of coronoid above the mandibular condyle	.06
Transverse diameter of the condyle (fractured)	.06
Elevation of condyle above level of angle	.125

DENTITION.—The teeth are quite well worn in some places, indicating an adult growth. The upper incisors are wanting, but were probably of the same number as the lower. In the latter series the second incisor is large. The incisor alveolus is short; if the first and third incisors were present they were rudimentary. The number of premolars in each jaw is also uncertain; the formula cannot, therefore, be stated positively. The teeth present characters which indicate an omnivorous diet, with strong carnivorous crowns in the anterior portion of the jaw. The *upper molar* series is six inches long, arching outwards from before backwards and diverging rapidly. The crowns of the upper molars (see Plate VI, Fig. 2) are nearly quadrate in shape, with smooth convex inner sides and a slight basal cingulum on the outer side. They each have four not very strongly marked lobes, sub-equal in size, except the last molar, in which the posterior lobes are much compressed. Each lobe rises to a low conical cusp, and these cusps are placed in transverse pairs. On the postero-internal lobe of the last molar is a small accessory tubercle, and there are very slight traces of these median tubercles on the other molars, suggesting the teeth of *Entelodon*, in which animal each molar bears six cusps placed in transverse rows of three each.[1] Although it does not appear so from the measurements given, the second molar is the largest owing to the larger size of the posterior lobes. The molars have two outer fangs and one inner double fang. Many of the molar cusps show a slight tendency to become crescentoid, a feature which is quite marked in *Achænodon vagus*.

The *upper premolars* have high pointed crowns with a slight basal cingulum.

The low anterior and posterior ridges bounding the inner angles of the teeth present a feature important in the consideration of the carnivorous resemblances of these teeth. The first and second premolars are two-fanged, the latter tooth set somewhat obliquely to the jaw. The third premolar has a high crown with a strong, low inner cusp; it is three-fanged. The *canines* are large, recurved and slightly oval in section; they recall those of *Hyænodon* or *Ursus*. If the tips were unworn they would extend fully an inch and a half below the line of the premolars.

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[1] Leidy, Ancient Fauna Nebraska, vol. vi. Smithson. Contributions to Knowledge, Plates VIII–X.

The *lower incisors*, judging by the sockets, are very compactly placed, almost in a semicircle between the canines, and directed obliquely upwards and forwards. Their position differs from that in *Entelodon*, where the alveolus is long and the teeth are placed widely apart. We possess the second incisor on each side below; the indications are that the medial and lateral incisors, if present, were extremely small. Two incisors which we suppose belong to the upper jaw are much smaller than the lower second incisors. All these teeth are worn very blunt; there is evidence, however, of an anterior cutting edge and a low cingulum behind. In Professor Cope's specimen the incisor alveoli are perfect, although the teeth are wanting; the teeth were arranged almost in a semicircle, appearing to have diminished in size towards the centre.

The *lower molars* resemble the upper, but are more compressed laterally. The first is the smallest molar in each jaw. Another feature is that the inner cusps are smaller than the outer. A generic character is found in the last lower molar, which possesses a strong posterior lobe and fang, as in the Pig. Judging from the Princeton specimen only, it would be difficult to determine positively the number of premolars. Cope in his brief description of *Achænodon* left it uncertain. Marsh described them positively as three in number in *Parahyus*. Behind the canine in our specimen is a small followed by a large socket; the former may have held a rudimentary single-fanged *premolar*, while possibly the two sockets held one double-fanged tooth. A peculiarity of these teeth is that they are placed close together, although not quite in contact. The last lower premolar is the largest of the series, but does not resemble the corresponding upper tooth in possessing an internal lobe.

Measurements of Teeth.

Lower Teeth, as worn.

	Vertical diameter of crown.	Antero-posterior diameter of crown.	Transverse diam. of crown.
	M.	M.	M.
canine,	.065	.030	.026
2d premolar,	.016	.024	.015
3d premolar,	.019	.029	.017
1st molar,	.01	.024	.017
2d molar,	.011	.026	.02
3d molar,	.012	.035	.022

Upper Teeth.

	Vertical diameter of crown.	Antero-posterior diameter of crown.	Transverse diam. of crown.
	M.	M.	M.
canine,	.066	.032	.028
2d premolar, (oblique,)	.02	.028	.018
3d premolar,	.02	.022	.028
1st molar	.006	.021	.026
2d molar	.01	.024	.031
3d molar	.015	.028	.029
incisor	.011	.013	.012

Total length of upper molar series (about 6 inches) .... .15 m.
Total length of lower molar series (about 7 inches) .... .175 m.

Ordinal Position of Achænodon. In general characters *Achænodon* presents a closer resemblance to *Entelodon* than to any other form. *Entelodon* (Pomel), first found in the Tertiary of Europe, was discovered by Leidy in the American Miocene. He at first referred it to *Archæotherium*,[1] but later ascertained its true position.[2] This resemblance establishes *Achænodon* as an Ungulate, but it differs widely from the modern Ungulate type in the conformation of its skull. It has some resemblances to the Bears, and some marked suilline features.[3] There follow a series of comparisons with several animals with which it has points of structure in common.

Likeness to Entelodon. The discovery of the skull adds to the number of characters distinguishing *Achænodon* from *Entelodon*, besides those which have been already noticed in the lower jaw. The generic distinctions of *Achænodon* may now be stated: (1) the probable loss of the anterior premolar in each jaw; (2) four cusps on the superior molars; (3) a fifth or posterior lobe on the last lower molar. Some species of *Entelodon* possess but four cusps on the superior molars, according to Kowalewsky. In most respects *Achænodon* has less of the suilline type than *Entelodon;* the fifth lobe of the last lower molar is an exception to this fact. The canines of some of our *Entelodon* specimens are flattened behind as in the Pig; those of *Achænodon* are rounded. The molars of the former genus resemble those of *Chœropotamus*, while the molars of *Achænodon* resemble those of the oldest *Suidæ*, such as *Palæochœrus*. The teeth of *Achænodon* are also set in a more compact series. In lateral view the skull of *Achænodon* is shorter and deeper; the face is less elongated than that of *Entelodon;* the post-orbital region is

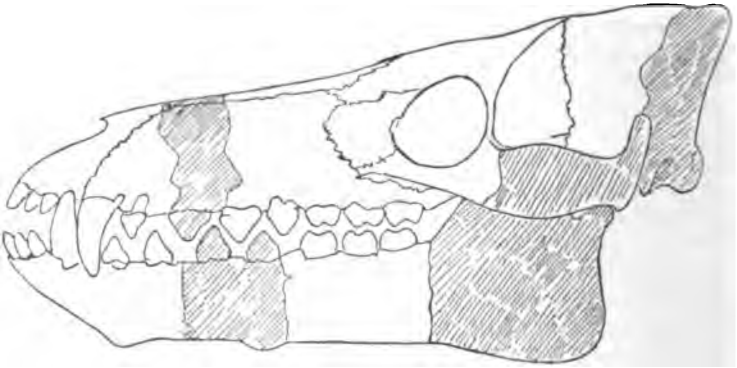

Fig. 2.—Skull of a Young Entelodon.

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[1] Ancient Fauna Nebraska, loc. cit.

[2] Extinct Fauna of Dakota and Nebraska, Plate XVI, p. 175.

[3] The points of structure connecting *Achænodon* with *Tetraconodon* have been enumerated above; the molars of the latter, with the accessory tubercles, show a nearer approach to the modern Pig or Hippopotamus type.

less elevated. A more important difference is seen in the peculiar shape of the glenoid fossa. On the other hand, an unmistakable affinity between the two genera is indicated by the general likeness in the dentition. Minor resemblances are seen in the mammilary tuberosities on the lower jaw, the shape of the angle of the jaw, the small size of the first lower molar. The drawings are restorations of the two skulls in the Princeton Museum, the *Achænodon* skull, also the skull of a young individual of *Entelodon*, assisted by Leidy's restoration.

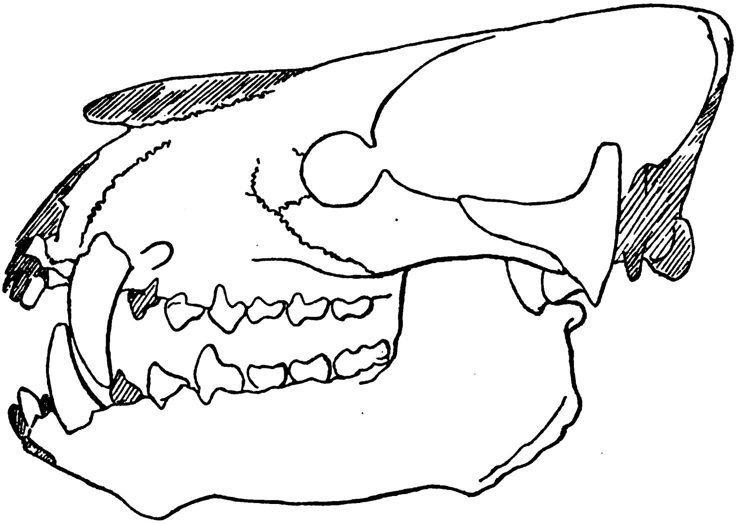

Fig. 3.—Skull of Achænodon.

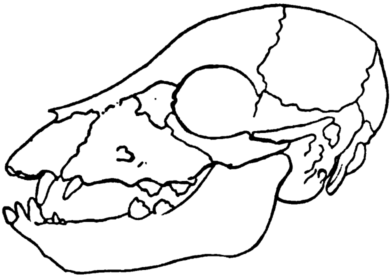

Fig. 4.—Skull of Young Pig (showing position of lachrymals).

Comparison with the Suidæ. The Pig characters are mostly contained below a line drawn forwards from the external auditory meatus within the zygoma, then downwards behind the last lower premolar; in other words, these characters predominate in the upper and lower molar series and the back part of the mandible. Here are marked suilline features: (1) the four-cusped molars of the Bunodont type; (2) the rounded angle of the jaw; (3) the erect coronoid; (4) the somewhat elevated mandibular condyle; and (5) the fifth lobe on the posterior molar. In this portion of the skull *Achænodon* recalls the skull of the Peccary rather than that of the Pig. Further resemblance to *Achænodon* in the Peccary's skull is found in the narrow but well-raised glenoid borders.

Outside the general region indicated above, the occiput begins to show the characteristic upward elongation, and the infraorbital foramen has the forward position which it has in the Pig. The exposure of the lachrymal bone upon the face is also an important feature.

As before noticed, the molar pattern is more like that of the

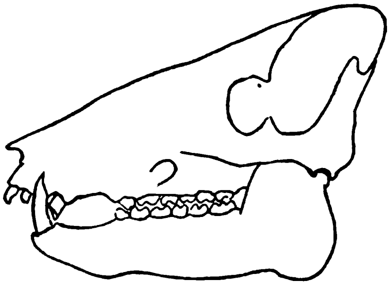

Fig. 5.—Skull of Peccary.

oldest of the Pig family than that of any of the modern forms; this arises from the simplicity of the molar cusps, which entirely lack the lesser tubercles found in *Sus scrofa*, for example, and are more like the cusps of *Sus antiquus*.[1]

While the above characters, which have a generic importance, relate *Achænodon* to the Ungulates, the structure of the skull is remarkable for its likeness to that of some of the ***modern and** ancient Carnivores*. This conformity of structure was at first regarded as indicating relationship, but this view was soon abandoned. The following homologies are pointed out as bringing out one of the most interesting phases in early Ungulate history—that of the adaptation of the skull partly to self-defence, partly to a mixed diet. Except for the elevated occiput, the actual size and proportion of the posterior and upper portions of the skull are almost identical with those of the California Bear (*Ursus arctos*). This likeness extends to the sagittal crest, to the shape and relative position of the orbit, as well as the bones of the zygomatic arch, the mandibular condyle and glenoid fossa. The last feature is, so far as we know, unique among the Ungulates. A comparison of Fig. 7: 1 and 2 shows the ursine shape of the glenoid fossa, also that in the development of a broad, well-rounded pre-glenoid border it differs from the *Palæosyops* (Fig. 7: 3) type, which closely resembles that of the modern Tapir. The angle of the jaw is much deeper than in any of the Carnivores, and the condyle is slightly more elevated. The premolars resemble those of *Hyænodon* in side view, but they are more obtuse and have not been worn by lateral attrition as in the Carnivora. The canines are blunted at the tips as in some old bears. The last upper premolar with its inner fang and heel suggests the carnassial tooth, but it is not opposed by any tooth corresponding to the lower carnassial.

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[1] DeBlainville, Ostéographie, vol. iv.; G. Sus, pl. viii.

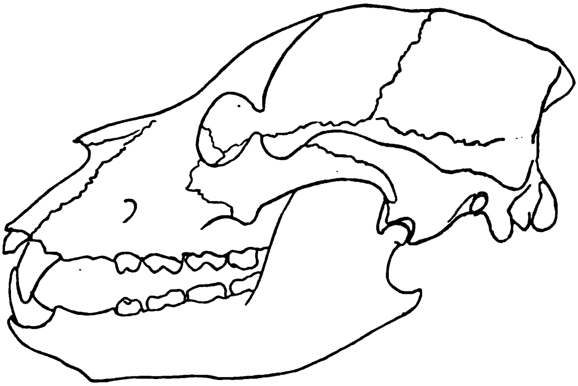

Fig. 6.—Skull of Ursus arctos.

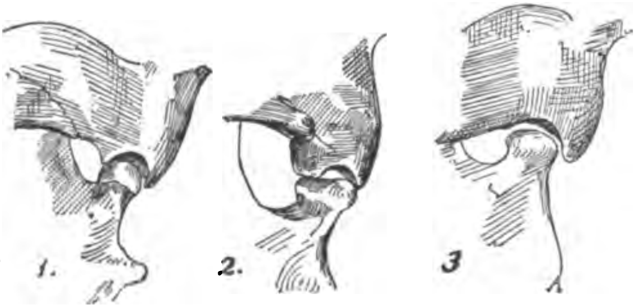

Fig. 7.—Glenoid fossæ: (1) of the Bear; (2) of Achænodon; (3) of Palæosyops.

The above resemblances are mostly to characters found in the oldest group of Carnivora, the *Arctoidea*,[1] which includes the Bears, Raccoons, Weasels and allied forms. Among extinct forms there is a strong likeness to some of the *Creodonta*, especially to the genus *Arctocyon*[2] of DeBlainville.

Our knowledge of *Arctocyon* is sufficient for comparative purposes and it is interesting to note that *Achænodon* and *Arctocyon* each have the same likeness to the Pig and the Bear. The following paragraph by M. Lemoine[3] is significant; it relates to the lower jaws of several individuals of *Arctocyon* found in France, and could be applied with equal truth to the jaw of *Achænodon:* " Effectivement si l'Arctocyon tient des carnassiers par ses incisives, ses canines et ses prémolaires; ses arrière-molairs rapellent à beaucoups d'égards certains types des Porcins, et chose curieuse, *la dent la plus développée chez les autres carnassiers, la carnassière est ici plus petite que les dents qui l'avoisinent.*"

From the drawings and descriptions by DeBlainville in the Ostéographie des Mammifères[4] and from M. Lemoine's articles we derive the following facts.[5] In both genera the last upper premolar suggests the carnassial tooth, while the first lower molar has no similar adaptation, but is the smallest of the molar series. The lower premolars of the two genera agree in having two roots and high, single, compressed crowns. In *Arctocyon Gervaisii*, as in *Achænodon vagus*, there are but three lower premolars, but the last inferior molar lacks a posterior heel. The upper molars of each animal are suilline. They resemble each other further in the ursine shape of the condyle and glenoid fossa. There is a great disparity in size between the two genera, *Arctocyon* being much the smaller. Accurate comparison with *Arctocyon* is difficult owing to the imperfection of the plates and descriptions in our possession. The coincidence of cranial and dental characters between *Arctocyon* and *Achænodon* is noteworthy, insomuch as it affords another illustration of the carnivorous specialization of the latter genus.

All the Eocene *Perissodactyla*, which are more or less allied to the Palæotherioid forms (see Fig. 8), have long been known to be characterized by carnivorous-looking skulls. *Orthocynodon* of the early Rhinoceros group presents somewhat similar characters. The discovery of the skull of *Achænodon* shows that this is true of the suilline types as well, and can therefore be safely called a characteristic of all the Eocene Ungulates.

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[1] See Prof. Flower, Class. of the Carnivora, Proc. Zool. Society, 1869.

[2] Professor Cope first called the attention of the writer to the resemblance of this animal to *Arctocyon*, and later to some of its apparently Creodont characters.

[3] Lemoine, Comm. sur les Ossements Fossiles, Soc. d'Hist. Nat. de Reims, 8 mai, 1878, p. 6.

[4] Tome ii., gen. Subursus, pl. xiii.

[5] Since I wrote the above M. Lemoine has sent me a copy of his " Étude du genre Arctocyon," Ann. des Sc. Nat., 1878, in which he compares the *Arctocyon* and *Entelodon* molars, and in which is found a full account of the dentition of *Arctocyon*.

Kowalewsky, in a valuable article upon *Entelodon*,[1] has pointed out this carnivorous conformation of the masticatory apparatus among the Tertiary Ungulates as having affected the adjoining portions of the skull. It undoubtedly is much more marked among the Eocene than among the Miocene Ungulates, all of which are more of the modern type. A comparison of one of these older skulls with more modern forms shows that there has been (1) a gradual elevation of the mandibular condyle and diminution of the coronoid; (2) the orbit has been apparently moving backwards owing to the forward elongation of the face; (3) the sagittal crest and deep temporal fossæ have disappeared; (4) the zygomatic arch has been gradually weakening; (5) in the Ruminant line the post- and pre-glenoid processes have alike almost wholly disappeared; in the Perissodactyle line the pre-glenoid process has wholly disappeared, the post-glenoid has become a heavy downward process, undergoing a peculiar series of changes among the *Rhinoceridæ;* (6) the lachrymals have been extending upon the face.

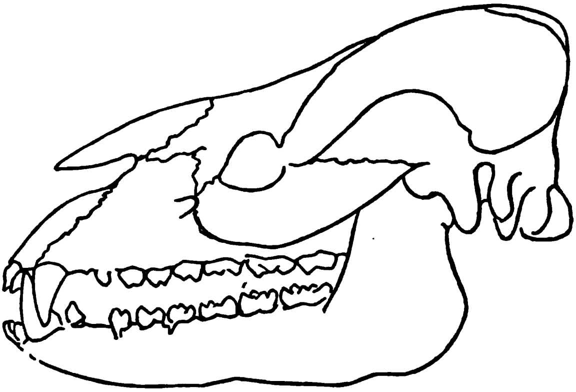

Fig. 8.—Skull of Palæosyops.

CONCLUSIONS.

The study of *Achænodon* gives fresh contradiction to an old error that a certain type of structure which we are in the habit of considering as peculiarly characteristic of a single order of animals is necessarily confined to that order. Here among an ancient group of even-toed Ungulates is a carnivorous structure of skull which is so extreme that the real relationships of the animal were hardly at first detected. The peculiar conformation of different portions of the skull is apparently so far from that of an Ungulate that from the portions of the skull in our possession the likeness of the dentition to that of *Entelodon* was at first the sole ground for assigning it to the Ungulates; later the exposure of the lachrymal bone upon the face was discovered, and afforded independent evidence that the skull did not belong to any true Carnivore, although this would not exclude it from the Creodonts.

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[1] Palæontographica, Band XXII, Seite 280.

The characters of the teeth of *Achænodon* show that it is a near ally of *Entelodon*, although it possesses one less premolar and has an additional lobe on the last lower molar. This likeness places it among the ancestral *Suidæ*, although the characters of the feet are still undetermined. The elevation of the occiput suggests the modern Pig, but in most respects the skull is very far removed from the Pig type. In all those parts of the skull which are related to the lower jaw or afford surface of attachment for the muscles of mastication the skull is strikingly like that of a Carnivore, the likeness of the teeth, the glenoid fossa, and the temporal region of this skull to that of the Bear being very remarkable. The combination of Bear and Pig characters is very similar to that found in *Arctocyon*, and there are some curious homologies between the two genera. *Achænodon* seems to present the most extreme modification towards the carnivorous type of skull which has as yet been observed among the Ungulates.

By uniting the facts in our possession concerning *Achænodon*, *Entelodon* and *Tetraconodon*, we can now form an estimate of the cranial and dental structure of the ancesibal *Suidæ*, although the derivation of the group still remains obscure. The brain case of the early forms was small, surmounted by a high, thin sagittal crest which spread out in the upper occipital region, forming a very deep and extensive temporal fossa. The occiput was narrow and concave above, but lacked the extreme upward and backward elongation of the modern forms. The orbit, partially surrounded by bone, was small and placed midway between the occiput and incisor alveolus; the face, therefore, was short and rounded. In keeping with these proportions, the parietals were as long as the frontals (as in the young modern Pig, see Fig. 4),and the first indication of the elongation of the face was in the extension of the lachrymals and malars upon the face. The zygomatic arch was very powerful, standing out widely from the skull. The glenoid fossa was wide, with strong post, and pre-glenoid borders (the pre-glenoid border is strong in *Achænodon*, it is retained in a less degree in *Entelodon*, and probably is still represented in the pre-glenoid process of the Peccary's skull). The mandible was deep with a rounded angle and condyle, but slightly raised above the molars. There were three molars in each jaw, which bore four simple conical cusps, the internal cusps being slightly smaller than the external; the third lower molar in some genera possessed a fifth posterior lobe. The premolars were four in number, with high, single, conical crowns, borne upon two fangs, except the fourth upper premolar, which had an internal lobe and third fang. The four canines were large, rounded, recurved and subequal in size. The incisors were three in each jaw, with anterior cutting edges, and almost erect in position.

III.

OBSERVATIONS UPON THE BRAIN CASTS OF TERTIARY MAMMALS.

By ADAM T. BRUCE.

Brain casts of fossil animals are intracranial moulds of the brain cavity, formed originally from a soft matrix which has subsequently solidified. The cranial bones may adhere to or become separated from the hardened cast. Casts from which the cranial bones have been separated are liable to fracture and weathering, which causes frequently render even approximate identification very difficult.

The casts which it is the purpose of this paper to describe, were, with the exception of a single Eocene form, collected from the White River Miocene of Colorado and Dakota. A detailed description of each cast will be followed by some general conclusions which their collective study seems to sanction.

The brain casts are figured in natural size in Plate VII.

UNGULATA.

ARTIODACTYLA (*Selenodontia*).

OREODON.

A series of brain casts, presenting the same general features, collected by the expeditions of 1882 and 1878 from the White River Miocene of Colorado and Dakota have been identified as casts of the cranial cavity of Oreodon. Proof has been mainly derived from the description of a brain cast of Oreodon given by Dr. Leidy, and from some Ungulate characters noticeable in the casts. The number of Oreodon remains found near the casts is additional evidence.

The gyri on the hemispheres make acute angles with the dorsimeson[1] posteriorly thus indicating an Ungulate type of brain. Dorsally three prominent gyri are apparent on each hemisphere. Their configuration is quite similar in all cases. A fourth gyrus, the sylvian, is apparent laterally above the hippocampal lobe. These gyri, according to Owen's nomenclature, would be the median, medilateral, supersylvian and sylvian. The median, in all cases, runs forward to a point on the line drawn at right angles to the dorsimeson from the anterior extremity of the temporal lobe, where it becomes continuous with the medilateral in some cases; in others, it bifurcates, becoming continuous with the orbital as well as with the medilateral gyrus. In the specimens represented by Figs. 1 and 3, a well-defined groove formed by the confluent lateral and supersylvian fissures, extending mesad, partially separates the median from the orbital gyrus. In specimens represented by Figs. 2 and *2a*, the median gyrus appears to be continuous with the orbital. The supersylvian gyrus is well defined, terminating in all cases anterior to the medilateral. The sylvian gyrus is separated from the supersylvian by a well-defined fissure. Its anterior termination is directly under the anterior termination of the latter. There are indications of moderate sized olfactory lobes in all cases, though these bodies are retained in none of the casts, the crura alone remaining. The temporal lobe is well defined in all cases. The hippocampal lobe is also quite prominent, being marked off from the sylvian gyrus by an ill-defined fissure. A prominent falx is noticeable between the hemispheres. There is a well-preserved representation of the decussation of the optic nerves in one specimen. The trigeminus nerve is prominent in all. The cerebellum is, in all cases, prominent and uncovered by the hemispheres. Its longest vertical axis, continued through the subjacent pons, is equal to the corresponding axis of the hemispheres. In some cases there are indications that the middle lobe of the cerebellum was divided dorsally by a line at right angles to the dorsimeson. This division does not appear in all cases, probably owing to the superficial deposit of matrix. The middle cerebellar lobe is very prominent in all cases, presenting a smooth unconvoluted surface. The lateral lobes, though well defined, have shorter transverse and vertical axes than the middle lobe: like the latter they are unconvoluted. Prominent flocculi appear on the lateral surface of the epencephalon.[1]

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[1] Line marking dorsal boundary of mesal plane. See Wilder's "Anatomical Technology" for explanation of terms.

A comparison with the brain of the pig does not bring to notice any very marked resemblances. The dorsal surface of the hemispheres is less elliptical, the temporal lobe being dorsally more prominent than in the pig. The cerebellum is relatively larger than the pig's, and is entirely uncovered by the hemispheres. Its median lobe is also more prominent than in the pig. The flocculi and trigeminus nerves are quite pig-like. The casts have been reduced to three ill-defined classes, represented by Figs. 1, 2, 3, 4. Fig. 4 represents a class differing somewhat from that represented by Fig. 1. The general similarity of the main features of the casts has already been pointed out. It remains only to notice some of the distinctive characters of each class. Fig. 1 represents a class having its hemispheres marked by very prominent gyri. The median gyrus unites with the medilateral posteriorly. The anterior extremity of the temporal lobe is well marked. In Fig. 4 the transverse axis of the hemispheres, is relatively longer than in Fig 1, consequently the cerebrum presents a more oval appearance dorsally. A cast considerably larger than Fig. 1, but resembling it in outline, probably represents a larger animal of the same species. Fig. 2 represents a class having the longitudinal axis relatively larger than the classes represented by Figs. 1 and 4. The extension of the axis is mainly due to the forward growth of parts anterior to the temporal lobe. The median gyrus becomes continuous with the orbital. The median and medilateral gyri do not become completely continuous, being separated by a shallow fissure. Fig. 2 *a* represents a cast probably belonging to this class, which has had its prominent features somewhat obscured by a superficial deposit of matrix. The former is from Chalk Bluffs, Colorado, the latter from the Bad Lands, Dakota. Fig. 3 represents a well-defined class, where the longest longitudinal axis of the hemispheres was apparently somewhat shorter than the longest transverse axis. Its chief peculiarity consists in the marked divergence of the median and medilateral gyri from the meson posteriorly. This cast is moulded from the light-colored matrix found at Chalk Bluffs, Colorado. The darker-colored matrix, noticeable in other casts, is common in the Dakota Bad Lands. The casts probably represent several species of Oreodon, including *O. Culbertsonii*, *O. Major* and *O. Gracilis*. In the appended measurements, the cerebrum is measured dorsally, hence its longitudinal axis is not extended through the restored olfactory lobes.

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[1] Wilder, loc. cit., "Segment including cerebellum and subjacent parts."

Measurements.

Cast I. (Fig. 1.)	mm.
Longest longitudinal axis of cerebrum	**47**
" transverse " " "	**42**
" vertical " " "	**31**
" longitudinal " " cerebellum	**25**
" transverse " " "	**27**
" vertical " " "	**32**

Cast II. (Fig. 2.)	mm.
Longest longitudinal axis of cerebrum	**45**
" transverse " " "	**39**
" vertical " " "	**34**
" longitudinal " " cerebellum	**34**
" transverse " " "	**30**

The vertical axis of cerebellum in all cases is measured through the entire epencephalon.

Cast III. (Fig. 3.)	mm.
Longest longitudinal axis of cerebrum	**38**
" transverse " " "	**40**
" vertical " " "	**23-4**
" longitudinal " " cerebellum	**20**
" transverse " " "	**22**
" vertical " " "	**24**

POËBROTHERIUM.

Fig. 5 represents a specimen from the Bad Lands of Dakota. From the characters of some of the cranial bones found adherent to the cast, particularly the large tympanic bullæ, and from the general resemblance of the cast to the brain cast of Procamelus, described by Prof. Cope, the specimen has been classified as Poëbrotherium. A conference with Prof. Cope confirmed this view. The gyri, converging anteriorly and making acute angles with the meson posteriorly, indicate an ungulate type of brain. The configuration of the gyri is quite similar to that of Procamelus described by Prof. Cope in the United States Palæontological Report of the One Hundredth Meridian.[1] The median and medilateral run well forward. The latter is subdivided longitudinally throughout nearly its entire length. The median appears to be similarly subdivided posteriorly. The supersylvian and sylvian are united anteriorly and posteriorly. These gyri run further forward than in Procamelus. The dorsal surface of the cast of the brain cavity of Procamelus is more oval, there being less inward flexure anterior to the terminus of the supersylvian gyrus. The lateral features of the cast present a general likeness to the corresponding portions of the brain cast of Procamelus; as in the latter there is a well-defined hippocampal lobe, separated from the sylvian gyrus by a well-defined fissure. The cerebellum is not well preserved in the cast. Probably it resembled the cerebellum of Procamelus. The surfaces of the cerebellar lobes are smooth. The middle lobe is prominent. The flocculi at the sides of the epencephalon correspond to those of Procamelus. The lineal dimensions of the cast are about two thirds the corresponding dimensions of Procamelus. The latter, however, was a larger animal, consequently the increase of cerebral capacity does not, in this instance, imply a progressive increase with advancing evolution.

	mm.		mm.
Longest longitudinal axis of cerebrum	51	**Longest longitudinal axis of cerebellum**	21
" transverse " " "	42	**" transverse " " "**	36
" vertical " " "	36	**" vertical " " "**	30

CARNIVORA FISSIPEDIA.

ARCTOIDEA.

MEGENCEPHALON PRIMÆVUS.

The cast of which Fig. 6 is the representation was found in proximity to the remains of an Uintatherium near Henry's Fork. The matrix is the green sandstone of the Bridger Eocene.

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[1] P. 338.

Compared with the smooth type of brain characteristic of many Eocene mammals the hemispheres of the cast are highly convoluted with sinuous longitudinal gyri. It is important to notice in this connection that as far back as the Bridger Eocene there are indications of large and small-brained types of mammals. In subsequent epochs the co-existence of these large and small-brained types became less marked owing to the disappearance of many representatives of the latter class. The preponderance which the large-brained [1] species acquired is well illustrated by the disappearance of the bunodont and the persistence of the lophodont Perissodactyla. The bunodont type represented by *Palæosyops* and allied forms possessed a small unconvoluted cerebrum with a large uncovered cerebellum and a prominent rhinencephalon, while the lophodont type represented by Aceratherium and Hyrachyus had a relatively larger cerebrum, marked by gyri and a smaller rhinencephalon.

By large-brained animals is understood those classes in which the ratio of the brain-weight to the body-weight is relatively large. In small-brained animals, on the other hand, this ratio is considerably less. The folding of the cerebral surface by bringing about a larger cerebral cortex is functionally equivalent to a larger unconvoluted cerebrum.

The brain of *Megencephalon primævus*, which the cast represents, belonged to one of the large-brained types of mammals found in the Bridger Eocene. A sacral vertebra found near the cast resembles the corresponding vertebra of the sea otter. The characters of the cast also suggest the brains of aquatic carnivora. The transverse axis of the cast is somewhat larger than its longitudinal axis, while the temporal lobe is ill-defined dorsally. The cerebellum is ill-defined, the ventral surface of the cast being very imperfect.

There are indications that the cerebellum was largely covered by the hemispheres. A depression originating in each hemisphere near the middle point of the dorsimeson (marked by a dotted line in the figure) extends backwards, diverging considerably. This depression possibly represents that part of the cerebellum left uncovered by the lateral divergence of the hemispheres. The broad transverse axis and the ill-defined temporal lobe giving the dorsal surface of the hemispheres an ellipsoidal appearance, suggest the brains of the seal, sea otter and dolphin. A comparison of the transverse with the longitudinal axis shows that the axes stand to each other in much the same ratio as do those of modern seals. The longitudinal axis is relatively shorter than the corresponding axis of the seal's brain, while it is relatively longer than the longitudinal axis of the dolphin's brain. The relative lengths of the axes agree much more closely with those of the seal than with the corresponding dimensions of the dolphin's brain. The portion of the cerebrum posterior to the sylvian fissure is relatively large, thus indicating a further relationship with the seal. These correspondences, taken with the probability that the median portion of the cerebellum was exposed dorsally by the lateral divergence of the hemispheres and " with the absence of extensive transverse sulci " (Spitzka) seem to identify the specimen as a cast of the brain cavity of an Eocene otter or of some allied form. Three main gyri, most apparent on the right hemisphere, may serve for purposes of description. The course of each is very tortuous and ill-defined. The median, extending the length of the hemisphere, is bisected by a depression at right angles to the dorsimeson, as in the seal. This depression in the cast has probably been considerably worn and has consequently been made unduly prominent. It is difficult to determine how closely the remaining gyri correspond to those of the seal's brain, owing to their tortuous course. They appear, however, to bear a general resemblance to the gyri on the hemispheres of the seal. The temporal lobe was apparently extended somewhat farther forward than in modern seals.

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[1] See Pal. Bull. No. I., this Museum, p. 20, Letter of Dr. Spitzka.

Heretofore no remains of seals have been found in the Eocene, although intermediate forms between the seals and the Cetacea, Zeuglodon and Squalodon, are found in the American Eocene.

Measurements.

	mm.		mm.
Longest longitudinal axis of cerebrum......	46	Cerebellum, very ill-defined, greatest width probably..................................	25
" transverse " " "	52		

CYNOIDEA.

GALECYNUS GREGARIUS (?), COPE.

A small brain cast (Fig. 7) from the Miocene formation of the Dakota Bad Lands is probably the cast of the brain cavity of a small carnivore. The straight longitudinal convolutions and the characters of the cerebellum give support to this view. The triangular shape of the dorsal surface of the cerebrum, due to the narrowing of the hemispheres anteriorly, suggests the brains of the Canidæ. The outlines of the cast also resemble the brains of some of the Mustelidæ, particularly the weasel's brain. The triangular shape of the cerebrum and the longitudinal direction of the gyri might indicate a relationship to the rodents. But the gyri are more distinctly marked than in modern rodents. From what is known of the brains of Tertiary mammals it is hardly possible that rodents of that period should have possessed more highly convoluted brains than the modern representatives of that order. From the features of the cast alone it would be rash to generalize; nevertheless it is very probable that the cast represents the brain of a species of Canidæ denominated *Galecynus gregarius* by Prof. Cope, inasmuch as representatives of that species are found in the Dakota Miocene. Judging from Prof. Cope's description, and from comparison with the brain cavity of a specimen in the E. M. Museum, there remains little doubt as to the identity of this cast. Its vertical axis appears to be somewhat shorter than the corresponding axis of the specimen examined. It is possible that this species of Canidæ combined some of the characters of the Mustelidæ, with more prominent canine characters. The special characters of the cast may be very briefly presented. There is no crucial fissure on the surface. The depressions of the hemispheres (marked by a dotted line in the figure) possibly mark the site of that fissure which has been obscured by the fracture of the cast at that point. The lateral fissure, separating the median and medilateral gyri, runs well forward. The medilateral and supersylvian gyri are separated by a fissure terminating above the sylvian fissure. The supersylvian and sylvian were probably separated by a continuous fissure extending from the origin of the olfactory crura over the sylvian fissure to the posterior part of the temporal lobe. The cerebellum is broad and convoluted, with a well-defined middle lobe.

Measurements.

	mm.		mm.
Longest longitudinal axis of cerebrum......	36	Longest longitudinal axis of cerebellum.....	13
" transverse " "	30	" transverse " "	23
" vertical " "	22	" vertical " "	15

AILUROIDEA.

HOPLOPHONEUS OREODONTIS (COPE).

The cast represented by Fig. 8, like the preceding, is from the Dakota Bad Lands. It differs from the preceding cast in size and in the configuration of the cerebral gyri. The well-defined gyri, running parallel with the dorsimeson, from which they diverge slightly anteriorly and posteriorly, indicate a carnivorous type of brain. There appears to be no crucial fissure. A slight depression of the median gyrus, a little anterior to the middle point, may represent a rudimentary crucial fissure. This, however, would place that fissure posterior to its present position. The same fissure may represent the prominent fissure formed at the junction of the median and medilateral gyri in the Felidæ. The blunted appearance of the hemispheres anteriorly, and the broad cerebellum with a somewhat prominent middle lobe, indicate affinities with the Ailuroidea. The gyri on the surface of the hemispheres are less tortuous than in modern Felidæ. The median and medilateral are separated throughout their entire length. The supersylvian and sylvian gyri are more distinct than in the modern Felidæ. The former is subdivided by a longitudinal fissure, which suggests a like fissure in the cat's brain.

The lateral aspect of the cerebrum is very similar to the cerebrum of the cat similarly viewed. The relatively long vertical axis through the temporal lobe is a marked feline feature. The cerebellum is partly covered by the hemispheres. Its middle lobe is somewhat more distinct than in modern Felidæ. The lobes of the cerebellum were probably smooth. The remains of several species of Felidæ have been found in the Bad Lands. The specimen may be provisionally classified as *Hoplophoneus Oreodontis*. A comparison of the cast with a skull and cast of Hoplophoneus at the Philadelphia Museum leaves little doubt on this point.

Measurements.

	mm.		mm.
Longest longitudinal axis of cerebrum......	**43**	**Longest longitudinal axis of cerebellum.....**	**18**
" transverse " "	**42**	**" transverse " " .....**	**36**
" vertical " "	**39**	**" vertical " " .....**	**30**

CREODONTA.

LEPTICTIS (LEIDY).

Fig. 9 represents the brain cast of a small Miocene mammal; portions of the skull found adherent to the cast, served to identify it as the brain cast of a small Creodont, described by Dr. Leidy as Leptictis. The most characteristic features of the skull are the prominent ridges extending along the inner border of the temporal fossæ. These ridges, together with the size and shape of the skull, and the character of the teeth, are sufficient to establish the identity of the cast. It is difficult to compare the cast with the brains of any specific group, owing to the generalized characters of Creodonts. They probably combined the characters of the Marsupials and Carnivora with some insectivorous characters. Hyænodon, a representative Creodont, closely resembles the marsupial Thylacynus. Hyænodon is also plantigrade and has a third trochanter on the femur. The cast indicates a simple type of brain, comparable with the brains of existing rodents. Its ventral surface is very incomplete. Dorsally the cerebrum is triangular in outline. There is a single ill-defined longitudinal fissure on each hemisphere, resembling a like fissure noticeable on the cerebra of some rodents.

There appear to be no indications of other fissures on the cerebral surface of the cast. The cerebellum is large, smooth and uncovered by the hemispheres. The cerebellar lobes are not distinct, the greater part of the cerebellum probably representing the middle lobe of higher mammals. The largest vertical cerebellar axis, measured, as in other cases, through the entire epencephalon, is somewhat longer than the corresponding axis of the cerebrum. The cranial bones suggest the size of the animal. Though probably it was as large as the weasel, the cast shows the animal's brain to have been somewhat smaller than the squirrel's brain. The single longitudinal fissure on the hemisphere apparently corresponds to a similar fissure on the cerebrum of the hedgehog. This correspondence may be of importance as indicating some insectivorous characters.

Measurements.

	mm.		mm.
Longest longitudinal axis of cerebrum,	19.	Longest longitudinal axis of cerebellum,	13.
" transverse " " "	21.	" transverse " " "	+
" vertical " " "	17.	" vertical " " "	17.

In most specimens the ventral surfaces were incomplete, consequently descriptions of parts pertaining to those surfaces have generally been omitted.

CONCLUSIONS.

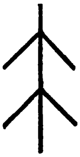
In conclusion it seems proper to point out some phases of encephalic growth which the casts described suggest. When comparison was possible, the casts, after making due allowances for the minor features of the brain which cannot be well represented by a cast, were found to be smaller and less highly convoluted than the brains of existing mammals of the same size and order. The casts of Oreodon were much smaller than the pig's brain: making deductions for the smaller size of Oreodon, which the numerous remains of its skeleton amply prove, it appears that the brain of the pig is relatively larger. The brain cast of Poëbrotherium does not admit of any exact comparison with the brains of existing Camelidæ.

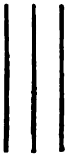
The brain cast of Megencephalon, tho smaller than the sea otter's brain, does not admit of any exact comparison with the brain of the otter, in the absence of the cranial bones. The brain cast of Hoplophoneus indicates a relatively small-sized brain. Tho probably as large as a panther, this animal had a brain not much larger than a cat.

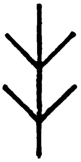
As before intimated, the brain of Leptictis must have been small considering the size of the animal. In all the casts where it is distinct, the cerebellum is nearly or entirely uncovered by the hemispheres. Moreover the cerebellum is, in most instances, of a relatively large size. Consequently, the evidence presented by the specimens described confirms the statement of Prof. Marsh, that most Tertiary Mammals had small brains, and that encephalic growth has been mainly confined to cerebral growth.

It seems probable that the primitive gyri on the dorsal surface of the hemispheres were ill-defined, and of the longitudinal type, running parallel to the dorsimeson with little flexure. The fact that the brains of Rodents, Edentates and Insectivora generally present this type of gyri, is evidence that the least differentiated gyri were arranged as stated. The brain casts of the Carnivora described, with the exception of *Megencephalon primævus*, exhibit nearly straight longitudinal gyri, not diverging from the meson anteriorly or posteriorly, as do the corresponding gyri on the cerebra of modern Carnivora. Moreover, the transverse crucial fissure prominent in existing Carnivora, if present at all, must have been quite rudimentary.

The evidence seems to sanction the view that transverse gyri were subsequent to longitudinal gyri, in order of appearance. The primitive longitudinal gyri may be supposed to be represented by similar gyri in the hemispheres of the lower Mammalia, and in a modified form by the gyri on the hemispheres of modern Carnivora. In the case of Ungulates, a modification of this primitive form of gyri may be assumed to have been effected by anterior convergence. In the history of Primates, a posterior convergence of the primitive dorsal gyri is also supposable.


1. Ungulate type.


2. Primitive type.


8. Primate type.

The large size of the cerebellum in fossil mammals has been pointed out. However, it does not necessarily follow from this that there has not been an increase of cerebellar cortex effected, as in the cerebrum, by the folding of the surface. The most noticeable feature of the cerebellum of the casts examined is the prominent middle lobe. Existing mammals of the lower orders possess a similarly configured cerebellum. In man the middle lobe is reduced to a minimum, the lateral lobes comprising the greater part of the cerebellum. It seems probable that there has been a decrease in the size of the middle lobe and a concomitant increase of the lateral cerebellar lobes with progressive evolution.

Moreover, the supposition that the middle cerebellar lobe of the Mammalia was primarily the largest cerebellar lobe is supported by embryological evidence, that lobe being prominent in the embryonic phases of the higher Mammalia, where it subsequently becomes smaller than the lateral lobes.

IV.

TWO NEW EOCENE LOPHIODONTS.

W. B. SCOTT.

I.—DESMATOTHERIUM GUYOTII. (*Gen. et spec. nov.*)

This interesting new form (Plate VIII, Figs. 1–3) is from the Bridger Eocene of Wyoming Territory, and represents a Lophiodont genus closely allied to *Hyrachyus*, but forming a link between that genus and *Tapiravus* of the Miocene. It therefore is very probably one of the direct ancestors of the Tapirs, and possibly also of the Rhinoceroses, but until the construction of the premolars in *Amynodon* is more perfectly known this point must remain undecided.

The specimen preserved in the Princeton collection exhibits the entire upper dentition, lacking the incisors only. The crown of the first premolar on each side is so broken as not to admit of description.

Definition of the Genus. Lophiodonts closely allied to *Hyrachyus*, having the molar teeth constructed exactly as in that genus, but differing from it in the pattern of the third and fourth upper premolars, which have two internal cusps instead of one. Dental formula:

$$i.\ \frac{?-?}{?-?}\ c.\ \frac{1-1}{?-?}\ pm.\ \frac{4-4}{?-?}\ m.\ \frac{3-3}{?-?}.$$

There is a long diastema between the canine and the first premolar.

Definition of the Species. The animal is of a size intermediate between *Hyrachyus agrarius* and *H. nanus.* The internal cusps of the third and fourth upper premolars are closely approximated and the crests low. The postero-internal cusp of the fourth is very small and situated somewhat exterior to the antero-internal cusp. The external accessory buttress is well developed on the teeth from the third premolar backward, and is indicated on the second. The cingulum of the last molar is raised into a tubercle on the anterior face of the crown.[1]

To describe the specimen somewhat more in detail. The first premolar is very small and evidently simple; of its crown nothing further can be said, as it is badly broken. The tooth was inserted by two fangs.

The second premolar is not essentially different from the corresponding tooth in *Hyrachyus;* the external face presents, however, a more nearly quadrate outline; the anterior edge is more nearly vertical and the antero-external buttress more distinctly marked. The external face is separated into two lobes by a groove deeper and more decided than in *Hyrachyus*. There is but one internal cusp, which sends off one very obscure anterior crest; this does not reach the external wall, but is separated from it by a longitudinal valley. The cingulum is faint, and is present only on the front and rear faces of the tooth.

The third premolar is very different from that of *Hyrachyus* in showing the molar pattern. The antero-external buttress is much larger than in that genus, being as well developed as in the molars. There are two internal cusps, and from each of them there proceeds a transverse crest to the external lobes. Of these crests the anterior is much the stronger. The two internal cusps are closely approximated, being separate only at their apices, and for the remainder of their height marked off from each other only by a deep groove. By this arrangement the median valley of the tooth does not open directly inwards, as it does in the molars.

The fourth premolar is larger than the third, and at first sight quite like the fourth premolar of *Hyrachyus*. But a closer examination reveals important differences. There are, as in the third premolar, two internal cusps, but this division is not so plain, as the posterior one is very small, and the posterior crest joins both it and the anterior cusp. The valley is therefore enclosed on all sides. The two external lobes in the three last premolars are of similar size and shape, thus differing from the molars. It cannot be said, therefore, that the third and fourth premolars are exactly of the molar pattern, though the beginning of the transformation is here very evident.

Besides the differences already mentioned between the last premolars of *Hyrachyus* and *Desmatotherium* there is another of less importance. In the former this tooth has the cingulum raised into a strong postero-external buttress, as well as into an antero-external one, thus giving the external face of the crown a four-lobed appearance.[1] In the latter genus this is not at all well marked; it is about as in the molars of both genera.

---

[1] This species is respectfully dedicated to my revered friend and teacher, Prof. Arnold Guyot.

The true molars of *Desmatotherium* are very similar indeed to those of *Hyrachyus*, but with some differences of detail. This genus agrees with the Lophiodonts and differs from the Tapirs in having the two external cusps somewhat unlike each other, the anterior one being convex and somewhat longer, the posterior one concave. In the Tapir, on the other hand, the two cusps are both convex and of similar size; the transverse crests are also less oblique, and the external wall of the tooth is not continued quite so far behind the posterior crest as in the Lophiodonts. *Desmatotherium* resembles the Lophiodonts in the type of its molars much more closely than it does the Tapirs, but perhaps the beginnings of change towards the latter may be detected. In the first molar the two external cusps are somewhat more alike than in *Hyrachyus*, and the external wall is not continued quite so far behind the posterior crest, so that the posterior valley is not so deep and has a somewhat different shape; the direction of the transverse crests is almost exactly the same. The antero-external buttress of the molars is of greater size relatively and more closely approximated to the antero-external lobe than in *Hyrachyus*, and more like the arrangement in the Tapir.

The cingulum is not very distinct except on the last molar. On the anterior face of this tooth the middle of the cingulum rises up to form a small prominence not seen in any of the species of *Hyrachyus* in our collection.

Through the whole series of molar teeth there is a progressive increase of size as we pass backwards, the first premolar being the smallest and the last molar the largest of the series.

The canines (Pl. VIII, Fig. 3) are very like the same teeth in *Hyrachyus*, though perhaps a trifle smaller. They are curved and provided with stout fangs. In direction they pass somewhat outwards as well as downwards. In section they are oval and depressed, the long axis being directed from side to side.

Measurements.

	M.
Length of entire molar series	.079
" " premolar series	.036
" " true molar series	.043
Fore and aft diameter of 1st *premolar*	.005
Transverse " " " "	.003
Fore and aft " " 2d "	.008
Transverse " " " "	.010
Fore and aft " " 3d "	.011
Transverse " " " "	.013
Fore and aft " " 4th "	.012
Transverse diameter of 4th *premolar*	.014
Fore and aft " " 1st *molar*	.013
Transverse " " " "	,016
Fore and aft " " 2d "	.015
Transverse " " " "	.016
Fore and aft " " 3d "	.017
Transverse " " " "	.017
Length of diastema between canine and premolars	.022

The especial interest of this new genus is morphological, and for the light which it throws upon the steps by which the Eocene Lophiodonts gave rise to the modern Tapirs. In order to understand this transformation it will be necessary to make a comparison between the extremes of the series and observe how the modern Tapir differs from such a form as *Hyrachyus*. The latter was an animal extremely like the Tapir in general appearance and in the broad characters of skull, skeleton and dentition, but at the same time displaying such differences from it as to necessitate placing it in another family.

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[1] See Leidy, Contrib. to Ext. Vert. Fauna of the West, Plate IV, Figs. 9 and 10.

(1) The skeleton of *Hyrachyus* a sa whole was lighter, the processes for muscular attachment less developed, and the limbs longer and more slender.

(2) The cranium was relatively smaller, the sagittal crest longer and the forehead less rounded, owing to the very small size of the frontal sinus.

(3) The nasals were probably longer and the narial opening not nearly so large.

(4) The upper canine was as large as the lower, which was erect.

(5) The premolars were all of a simpler pattern than the molars, having only one internal cusp.

(6) In the molars the two external cusps were of different shape, the anterior being convex and the posterior concave, while in the Tapir they are both convex.

(7) The antero-external buttress was not so closely applied to the neighboring external cusp.

(8) The neck was somewhat longer.

(9) The scapula was larger relatively.[1]

(10) The ilium had a much longer plate.[1]

(11) The limbs were longer and more slender proportionally.

(12) The radius was less expanded distally, and never co-ossified with the ulna.

(13) The pisiform articulated with the ulna by a much smaller face, and covered less of the cuneiform.

(14) The magnum was very much smaller, and the unciform somewhat larger.

(15) The metacarpals were longer and more slender; the median one not so stout; and the lateral ones, especially the fifth, better developed.

(16) The astragalus and calcaneum were longer and narrower.

(17) The metatarsals show the same differences from the modern forms as do the metacarpals.

It will be at once apparent that most of the changes which have taken place in this line are comparatively insignificant and easily intelligible. It is only in the dentition that the successive steps can be followed by means of the material which has as yet been discovered, yet we cannot doubt that the fresh material which is constantly brought to light will confirm the determinations made from the successive modifications of the teeth.

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[1] See Cope, Sixth Ann. Rep. U. S. Geolog. Survey of the Territories, 1872, p. 603.

The molars of *Hyrachyus* are strikingly like those of the Tapir, showing even the small accessory ridge which projects from the external wall into the median valley, and the antero-external buttress of the crown. There is a difference, however, in the fact that in the molar tooth of the Eocene type the antero-external cusp is convex, while the posterior one is concave. If, as has been suggested by Prof. Cope, and as is extremely probable,[1] the Lophiodont form of dentition is a modification of the *Palæosyops* type in which the external cusps are both concave, this inequality has nothing surprising in it. Two kinds of Perissodactyl molars seem to be derived from the Lophiodont type; one is that of the Rhinoceros and *Hyracodon* series (see the first article of this Bulletin), the other the Tapiroid type. The first step towards the latter series is seen in *Desmatotherium*, where the inequality of the external cusps of the first molar is less marked and where the premolars are beginning to assume the molar pattern. This transformation has hardly gone far enough for us to say that they are alike, yet the third and fourth premolars present all the elements of the molar tooth.

In the Lower Miocene the genus *Tapiravus*[2] of Prof. Marsh carries the modification further still in that the fourth premolar is exactly like the molars. He does not state anything as to the equality or otherwise of the external cusps. *Anchisodon* (Cope[3]) has the third and fourth premolars both on the molar pattern, and Prof. Cope includes this genus among the family *Tapiridæ*. The place of *Desmatotherium* in the line of the Tapirs seems thus to be perfectly clear. It represents the first step of the modifications which gradually metamorphosed *Hyrachyus* into *Tapirus*. That both of these genera belong in the series of direct ancestors of the Tapir seems at present hardly open to question.

The relations of *Desmatotherium* to the Rhinoceros line are by no means so evident. It would not be surprising if future discoveries were to show that this genus, and not *Hyrachyus*, were the common starting-point of the Rhinoceros and Tapir lines, and yet from the evidence which we have at present this seems hardly probable. *Amynodon* appears to have simpler premolars than *Desmatotherium*, and even if it should turn out that in this form the premolars have two internal cusps, yet the stratigraphical evidence is that *Orthocynodon* is an older form than *Desmatotherium.* This latter objection may of course at any time be removed, and should be allowed only a negative value.

---

[1] Cope, Journ. Acad. Nat. Sci. Phila., 1874, pp. 13, 14.

[2] Am. Journ. Sci. and Arts, 3d ser., vol. xiv. p. 252.

[3] Am. Nat., 1879, p. 270.

We have seen in the first paper of this Bulletin that probably the first change from *Hyrachyus* towards the Rhinoceros lines was in the transformation of the molar teeth to the characteristic Rhinoceros pattern, especially by the great reduction of the antero-external cusp. In *Desmatotherium* what little difference from the molars of *Hyrachyus* there is, points rather to an equalization of the cusps, the great change being in the character of the premolar teeth.

Taking, therefore, everything into consideration, it must be admitted that the tendency of our knowledge at present is to place this new Lophiodont only in the ancestral line of the Tapirs, although, as I have already said, it may very well happen that future investigations may prove that it also stands in a similar relation to the Rhinoceroses.

II.—DILOPHODON MINUSCULUS. (*Gen. et spec. nov.*)

(Plate V, Fig. 4).

This genus is established on a portion of the lower jaw, embracing the right ramus with the entire molar series and the symphysis, but lacking the canines and incisors. The specimen was found in the Bridger Eocene of Wyoming Territory.

Definition of the Genus. Lophiodonts closely allied to *Hyrachyus*, having the last lower molar with two transverse crests, and a diastema between the canines and molar series, but with only three premolars in the lower jaw.

Definition of the Species. (1) *Dilophodon* (*Hyrachyus*) *nanus*, Leidy. Last lower molar with a small posterior heel; diastema between canines and molars very long.

(2) *D. minusculus*, Scott. Animals considerably smaller than the foregoing species; last lower molar without any trace of a posterior heel; diastema very short.

It was with considerable hesitation that this genus was formed, for such a character as the absence of the first lower premolar is not always a safe criterion, but its constancy even in young specimens, and its occurrence in two such entirely distinct species, made it evident that this is not merely an uncertain variation. If it be thus a constant character, there can be no question that it has a generic value.

The specimen before us is one of the smallest of the known Lophiodonts. It was from an animal barely adult, as the first molar is but slightly worn, and the crown of the last molar is not yet protruded to quite its full height.

The jaw is shaped like that of *Hyrachyus*, rather deep and with a thickened alveolar border. Behind the molars the ramus becomes very thin and is extended far back. The short diastema indicates rather a short-headed animal. The symphysis is very narrow and apparently quite short, so that the canines and incisors must have been closely crowded together; the jaw is broken off close to the roots of the former. The jaw is much contracted at the symphysis, though it was not very wide in any part.

There are three small mental foramina, which occupy a very similar position to those in *D. nanus*, but owing to the shortness of the diastema they are brought closer together and lie all in the same straight line; the posterior one lies just below the space between the first two premolars (second and third of the full series). These foramina are very small, much more so than in *D. nanus* (see Leidy, Contrib. to Ext. Vert. Fauna of West, Pl. XXVI, Fig. 11). At the diastema the alveolus is contracted to a very thin edge, which curves down and then up again to the insertion of the canine.

Dentition. As far as can be judged from the broken roots, the incisors are like those of *Hyrachyus*, both in number, shape and size. The roots are much compressed and the crowns are apparently somewhat procumbent. The canines are very small indeed, though this may be a characteristic of the sex of the animal rather than of the species.

There is no trace whatever of the presence of the small first premolar. As already stated, the animal was barely adult, and so the absence of this tooth cannot be due to age.

The second premolar (first in this genus) is a small tooth inserted by two fangs. It is very similar to the corresponding tooth in *Hyrachyus*, but has the anterior fossa a little more distinct.

The third premolar shows no differences from that of *Hyrachyus.*

The fourth premolar is rather more like the molars than is the case in *Hyrachyus*, in the somewhat greater elevation of the posterior crest. All the premolars, however, as in that genus, have the anterior lobe considerably higher than the posterior, but the elements of the molar teeth are present in the third and fourth at least, and it would require only a very slight change of proportion to reduce these teeth to the molar pattern.

The molars of the specimen before us call for no special description, as they are precisely like those of *Hyrachyus*. The last one is the largest, and has no trace of the heel which is to be seen in *D. nanus*, far less of the third lobe which is found in *Lophiodon* and *Helaletes.*

Measurements.

	M.		M.
Length of entire molar series	.045	Transverse diameter of 1st molar	.006
Length of premolar series	.019	Fore and aft " " 2d "	.009
Length of true molar series	.026	Transverse " " " "	.006
Fore and aft diameter of 1st premolar	.005	Fore and aft " " 3d "	.009
Transverse " " " "	.004	Transverse " " " "	.007
Fore and aft " " 2d "	.007	Diameter of canine at base	.003
Transverse " " " "	.005	Length of diastema	.014
Fore and aft " " 3d "	.007	Breadth of symphysis at canines	.008
Transverse " " " "	.006	Depth of ramus beneath 1st premolar	.013
Fore and aft " " 1st molar	.008	" " " " 3d molar	.017

The following systematic table of the genera of the *Lophiodontidæ* may be of some value in showing the various modifications which this group presents.

LOPHIODONTIDÆ.[1]

Perissodactyls having the external cusps of the upper molars of different shape from each other; upper and lower molars supporting transverse crests. Molars and premolars unlike.

I. Anterior digits three. *Triplopus.*
II. Anterior digits four.
  1. Nasals supporting a pair of rudimentary horns. *Colonoceras.*
  2. Nasals hornless.
    a. No diastema between canines and premolars. Last lower molar with three lobes. *Helaletes.*
    b. A diastema between canines and premolars.
      (1) Upper premolars with one internal cusp.
        (*a*) Transverse crests of lower molars connected by oblique crests. *Pachynolophus.*
        (*b*) No oblique crests in lower molars.
          aa. Last lower molar tri-lobed. *Lophiodon.*
          bb. Last lower molar bi-lobed.
            A. Molar series $\frac{7}{7}$. *Hyrachyus.*
            B. Molar series $\frac{7}{6}$. *Dilophodon.*
      (2) Third and fourth upper premolars with two internal cusps. *Desmatotherium.*

I have not included *Tapirulus* in the above list, because Gervais's figure and description give no reason for separating it from *Lophiodon*. Prof. Cope can hardly be right in considering *Helaletes* a synonym of this genus.

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[1] This definition modified from Cope; Bull. U. S. Geolog. Survey, vol. v. no. 2, p. 228.

EXPLANATION OF THE PLATES.

PLATE V. ORTHOCYNODON ANTIQUUS.

Fig. 1. Side view of skull, restored.
Fig. 2. Crowns of the superior molar series.
Fig. 3. Crowns of inferior molar series.
Fig. 4. Crowns of median lower incisors.
Skull one half natural size, other figures two thirds natural size.

PLATE VI. ACHÆNODON ROBUSTUS.

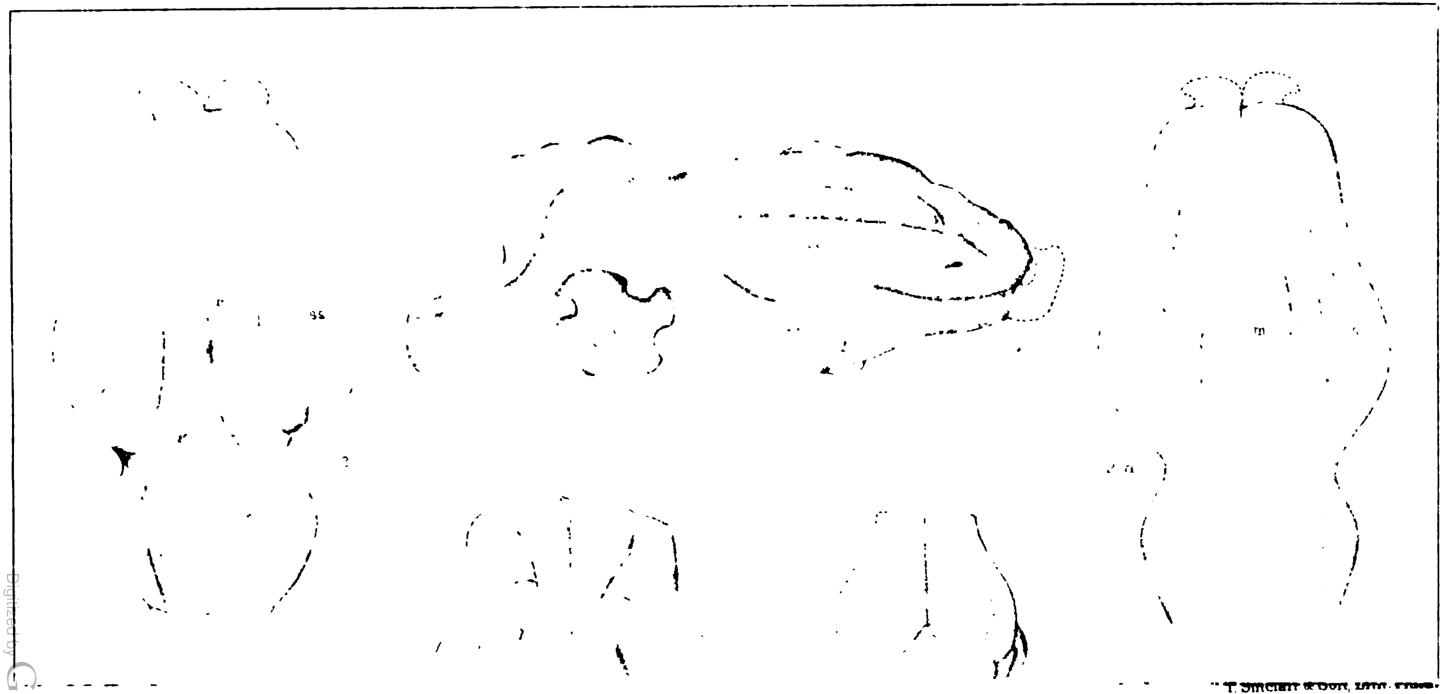
Fig. 1. Side view of the skull, restored.
Fig. 2. Crowns of upper canine and molar series.
Fig. 3. Crowns of lower canine and molar series.
Figures one half natural size.

PLATE VII.

Fig. 1. Side view of cranial cast of OREODON. (Class I.)
Fig. 2. Dorsal view of cranial cast of OREODON. (Class II.)
Fig. 2*a*. Dorsal view of cranial cast of OREODON.
Fig. 3. Dorsal view of cranial cast of OREODON. (Class III.)
Fig. 4. Dorsal view of cranial cast of OREODON.
Fig. 5. Dorsal view of cranial cast of POEBROTHERIUM.
Fig. 6. Dorsal view of cranial cast of MEGENCEPHALON PRIMÆVUS.
Fig. 7. Dorsal view of cranial cast of GALECYNUS GREGARIUS (?).
Fig. 7*a*. Lateral view of the same.
Fig. 8. Dorsal view of cranial cast of HOPLOPHONEUS OREODONTIS.
Fig. 8*a*. Lateral view of the same.
Fig. 9. Dorsal view of cranial cast of LEPTICTIS.
m, median gyrus; *l*, lateral gyrus; *ss*, supersylvian gyrus; *s*, sylvian gyrus; *o*, orbital gyrus.
Figures natural size.

PLATE VIII.

Fig. 1. Right superior maxillary of DESMATOTHERIUM GUYOTII.
Fig. 2. Fang of right superior canine of the same.
Fig. 3. Crowns of superior molar series of the same.
Fig. 4. Right mandibular ramus of DILOPHODON MINUSCULUS.
Figures natural size.



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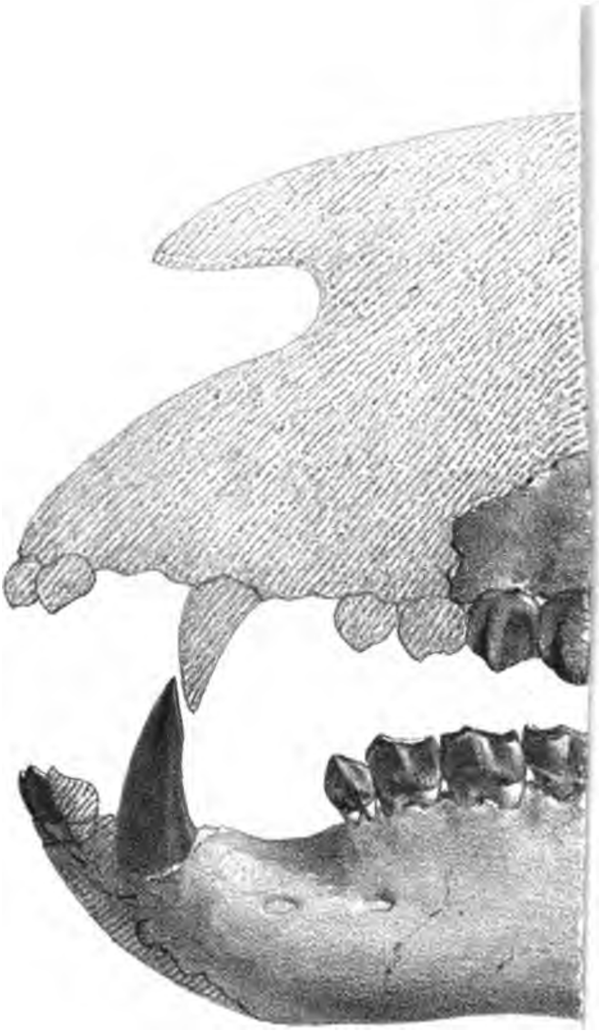
8 HOPLOPHONEUS OREODONTIS 9 LEPTICTIS



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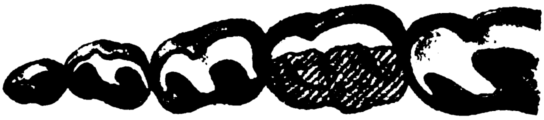
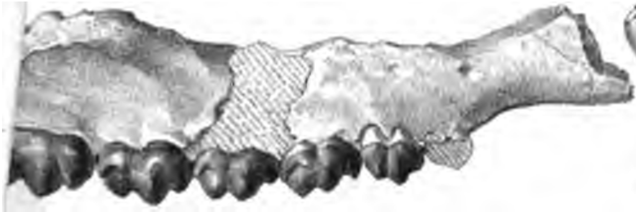


1 SKULL 2

Plate VIII



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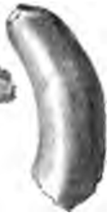

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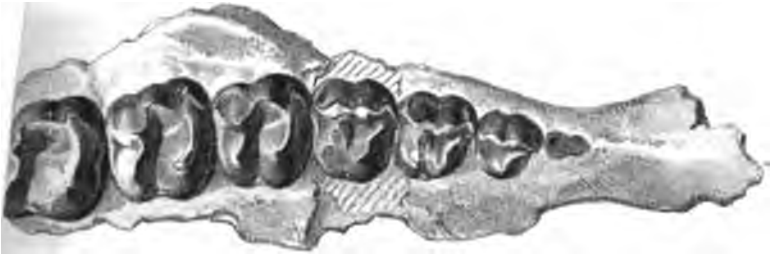

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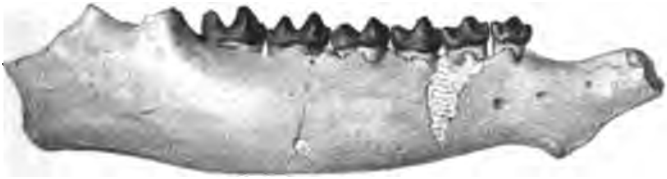
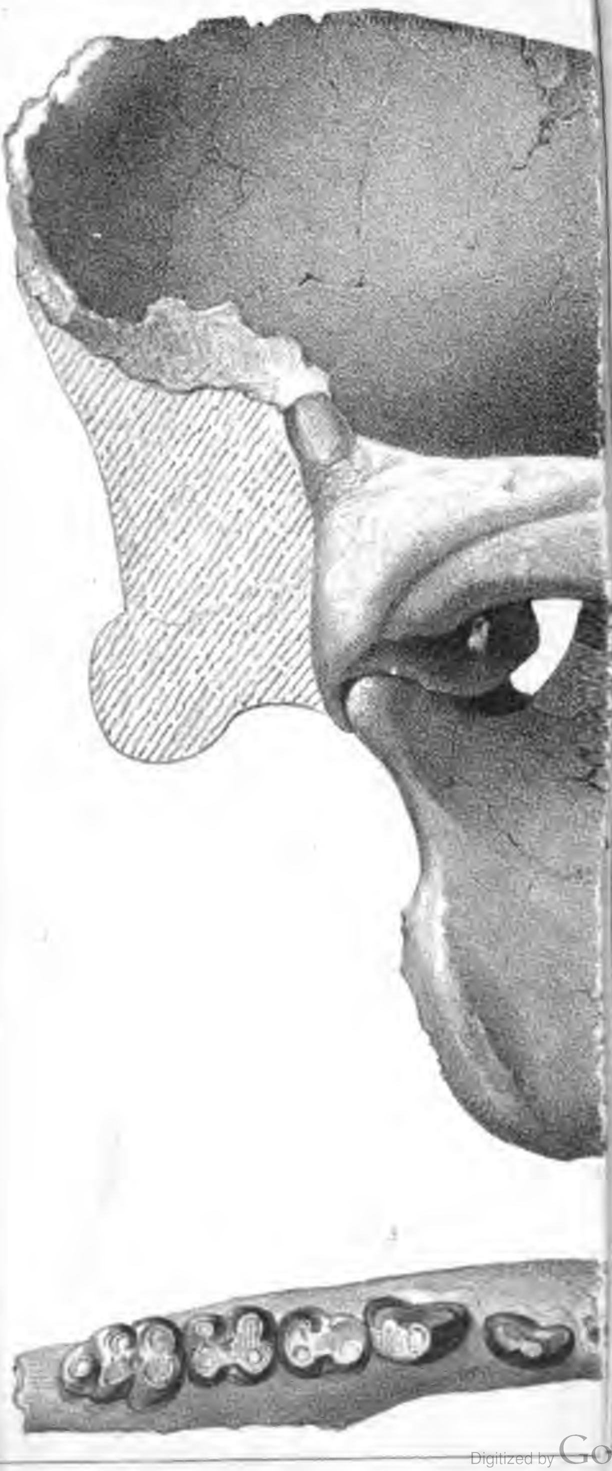


4

1-3 DESMATOTHERIUM GUYOTII 4 DILOPHODON MINUSCULUS

Drawings natural size



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